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UNITED STATES ATOMIC ENERGY COMMISSION

Nuclear Science Abstracts

Vol. 3 No.11
Dec. 15, 1949

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Technical Information Division, Oak Ridge, Tennessee
AEC, Oak Ridge, Tenn., 12-15-49--1950-A12391

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GENERAL

2038 Atomic-powered plane hurls challenge at engineers. Andrew Kalitinsky. Soc. Automotive Engrs. J. 57, 44-7(1949) Jan.

The advantages of using atomic energy to power a plane are noted and some of the engineering problems this would involve are considered. The basic types of power plants which might be suitable for adaptation to atomic energy usage are shown. They are: (1) steam turbine, (2) turbojet, (3) ramjet, and (4) rocket. The problem of high temperatures, which are necessary for high performance, is discussed. It is suggested that the components of a nuclear engine would be an engine, reactor, and shielding, which would correspond to the conventional powerplant proper, fuel, and fuel tanks, respectively. Some of the possible means of reducing the shielding weight (another major problem) are noted.

BIOLOGY AND MEDICINE

2039 On the claimed transmutations of elements in plants: iodine in Laminaria flexicaulis. Émile Rinck and Jean Brouardel. Compt. rend. 228, 263-4(1949) Jan. 17 (in French).

The authors have undertaken a critical study of the work of Freundler et al. (Bull. soc. chim. France 37, 1466(1925)) and Spindler (Bull. lab. maritime Dinard 28, (1946): 31, (1948)), which it is suggested that in Laminaria certain elements, such as iodine and potassium, are able to change by atomic transmutation. This conclusion was based on the assumption that normally iodine is evenly distributed throughout the plant, and any variations in distribution were attributed to transmutation. The present analysis of 500 samples taken from a group of 50 Laminaria flexicaulis, at different times, indicate that these assumptions are false, since (1) algae collected at the same time and place did not present the same iodine content, in fact, the differences sometimes surpassed 100%; (2) uniformity of distribution did not exist since the iodine content was found to vary along the length of the plant; (3) iodine content of samples which were fixed (killed) at regular time intervals, and which would necessarily show a systematic variation according to the previous reports, was in all cases comparable with that of the controls. At the same plant height the iodine content was always in the zone of dispersion observed in the controls. Therefore, it is assumed that the previous reports of evolution of iodine by transmutation rest on erroneous experimental bases.

2040 On the claimed transmutation of elements in plants: potassium in Laminaria flexicaulis. Jean Brouardel and Émile Rinck. Compt. rend. 229, 240-1(1949) July 18 (in French).

The second portion (Compt. rend. 228, 263(1949)) of a critical study of the work of Freundler (Bull. soc. chim. France 37, 1466(1925)) and Spindler (Bull. lab. maritime Dinard 28, (1946) Dec.; 31, (1948) June), in which an attempt is made to disprove that the potassium content of Laminaria flexicaulis varies by transmutation. The study of 150 samples of nine algae showed that the distribution of potassium in the plants is not constant and that there is a rapid and important variation of potassium content along the length of the stalk. In samples fixed (killed) at regular time intervals and increasing from the time of collection, it was shown that whatever the time of fixation, the distribution of potassium followed the laws of simple hazard. Since Spindler took only two control samples it may be assumed that the variations which he observed were due to the position in the plant of the samples taken. As in the case of iodine (Compt. rend. 228, 263(1949)), the conclusions of Spindler affirming the existence of transmutations rest on erroneous experimental bases.

2041 The effects of uranium dioxide powder applied subcutaneously through an incision in the skin of rabbits. Roberta Allen. AECD-2709, May 23, 1949. Decl. Oct. 4, 1949. 7p.

Insoluble UO_2 was applied in incisions made under the skin of 4 rabbits to determine its effect on wound healing and the extent, if any, of its systemic absorption. The animals, as compared with 3 controls (incision only), were observed for a month for local and systemic changes and finally, an analysis of the skin area was made to determine the amount of uranium remaining at the site of application. The normal course of wound healing was not altered by the administration of as much as 40 mg of UO_2 powder to a 3 cm incision, nor was uranium absorbed to any significant degree from its site of application.

BIOLOGY AND MEDICINE (continued)

2042 The inhalation toxicity of beryllium sulfate mist at a concentration of 1 mg/m^3 for 10Q days. Robert H. Hall, Norman J. Ashenburg, Alton Pettengill, James K. Scott, Charles J. Spiegl, Frank A. Smith, Luville T. Steadman, Sidney Laskin, and H. E. Stokinger. AECU-568(UR-84), June 25, 1949. 62p. (See also NSA 2-1330; 2-1512; 2-1513).

In a fourth of a series of decreasing exposure concentrations, borderline toxicity has been produced in animals inhaling 1 mg/m^3 of beryllium sulfate hexahydrate mist (40 μg Be/m^3) of small particle size (0.25 μ), daily for a period of 100 days. No deaths occurred from the exposure in any of the 171 animals representing 7 species; and weight losses except in 2 species, the dog and the cat, were not particularly marked (10-20%). Four species gained an equivalent weight increment; and one, the hamster, neither gained nor lost. Exercised hamsters showed no differences in beryllium response histologically from those without exercise but receiving the same amount of inhalation exposure, thus differing strikingly from hamsters in a similar experiment at a 10-fold higher beryllium concentration in which 100% mortality occurred in the exercised group. More prominent and consistent was the production in dogs of a macrocytic anemia simultaneously with altered amounts of red blood cell lipids, lowered arterial oxygen tension, and lowered serum albumin and globulin. The anemia was uniformly produced in all dogs in from 3-8 weeks of exposure and was characterized by a decrease of approximately 2 million red blood cells, a 1-2 gram per cent hemoglobin loss, and mean red red blood cell volume elevation to over 100 μ^3. The amounts of red blood cell phospholipids increased to approximately 2 standard deviations above the normal range at some time during exposure but free cholesterol increases were not so marked, amounting to 1 σ. These changes occurred, however, in all exposed dogs as did small and somewhat temporary changes in serum proteins. These manifold responses, appearing at such low concentrations of beryllium, may have arisen in part from the extremely small particle size (0.25 μ) of the inhaled mist and a consequent deep penetration into the alveoli. Histologic changes remaining at the termination of exposure were restricted to the lungs and in only 2 species, the dog and the rat, in which definite lesions could be demonstrated. Not all members of these species, however, showed injury; only questionable changes occurred in the monkey and the cat. Serial examination of rabbits showed no regular response with increasing exposure thus indicating the borderline nature of the exposure. Tissue deposition of beryllium at the termination of 100 days of exposure revealed strikingly small quantities of beryllium in the lung, of the order of 0.1 to 1.5 μg/g; amounts in the femur were of the order of 0.01 to 0.1 μg, and amounts in the liver some times were as low as 0.004 μg/g. Moreover, it was found that these lower concentrations persisted without appreciable change in the soft tissues as well as in the bone for periods of from 8-10 weeks. These data were found in the hamster by spectrochemical analysis of the tissues at 2-week intervals after termination of exposure. 19 references.

2043 Acute and chronic beryllium poisoning. Harriet L. Hardy. AECU-569, nd. 7p.

The following items are discussed briefly: the appearance of beryllium toxicity among industrial workers; details as to the nature and occurrence of beryllium poisoning; characteristics and control of acute respiratory diseases caused from beryllium and of chronic beryllium disease.

2044 Effect of uranium poisoning in partially pancreatectomized dogs. F. Grande Covián, J. C. de Oya, and C. Jiménez Diaz. Bull. Inst. Med. Research, University Madrid 2, 53-5 (1949).

The results of experiments in which dogs were partially pancreatectomized (70-80%) and were observed for the incidence of diabetes are described. It was shown that diabetes did not occur in these dogs; blood sugar levels were normal. In dogs treated similarly, but also given 3 mg/kg of uranium nitrate parenterally after the pancreatectomy, no incidence of diabetes was demonstrated.

2045 The employment of BAL in a case of arsenic intoxication. R. Suriyong. Rev. med. Suisse romande 68, 757-65(1948) Nov. 25 (in French).

A description is given of the chemical configuration of BAL (British-anti-lewesite) and a case is presented which illustrates its value in the chemotherapeutic treatment of arsenic poisoning. The

BIOLOGY AND MEDICINE (continued)

treatment of the patient began with the administration of intramuscular injections of 5% BAL in oil solution twice a day for the first four days; the number of injections per day was then reduced to one due to a painful reaction to the injections; the amount was later increased to 2 cc of 10% BAL solution a day, and in all the patient received 2.4 g of BAL. The results were favorable since the treatments were begun only about a month after the first symptoms of intoxication appeared; two weeks after the treatment began a striking and rapid amelioration of the symptoms appeared and the patient passed from a state of tetraplegia with doubtful prognosis to a state of paresis, which could be improved by habitual physio-therapy. The authors state that generally, the results of the treatment of chronic cases of arsenic poisoning are less favorable.

2046 Taking the brrr out of beryllium. Herbert T. Walworth. Ind. Med. Surg. 18, 428-31 (1949) Oct.

This article points out some of the common industrial sources of beryllium poisoning; the symptoms of the disease and suggestions for its control are included. The two general manifestations of exposure to beryllium are dermatologic and respiratory; the dermatologic manifestations consist of contact dermatitis and chronic skin ulceration, while the respiratory reactions are chemical bronchitis and chemical pneumonitis. There is often a delay of up to six years following exposure before the respiratory symptoms appear. Industrial processes such as the manufacture of beryllium-copper alloys, electric sign tubes, and fluorescent lamps are noted as sources of beryllium poisoning. Such protection measures as ventilation and respiratory protection are described and new methods of detection of beryllium and measurement of the toxicity of beryllium compounds are discussed.

2047 The urinary excretion of citrate in uranium poisoned rats. Frances L. Haven and Challiss Randall. J. Biol. Chem. 175, 737-44(1948) Sept.

Following the administration to rats of single intraperitoneal doses of 2.5 mg of uranium nitrate/kilo, the urinary excretion of citrate rose in 3 days to 3 to 4 times the normal level; a return to the normal level was followed by a secondary rise of equal magnitude. When a rat received increased doses of uranium nitrate at 12-day intervals, the urinary excretion of citrate was high each time a larger dose was given. At the time of administration of 5 mg of uranium nitrate to a rat that had previously received 11 injections of 0.33 mg/kilo (a dose which causes tolerance) the excretion of citrate was twice the normal; when the repeated dose consisted of 0.11 mg/kilo (a dose too small to cause tolerance), the urinary excretion of citrate was normal at the time the dose of 5 mg/kilo was given. High concentrations of citrate within the kidney tubule appear to result in formation of a soluble complex with uranium and thus protect against the toxic action. 23 references.

2048 Studies on the metabolism of thiourea. I. Distribution and excretion of thiourea labeled with radioactive sulfur. John Schulman, Jr., and Richard P. Keating. AECU-582(LADC-711), nd. 14p. Proposed for publication in J. Biol. Chem.

Thiourea labeled with radioactive S^{35} has been intraperitoneally injected into rats, and its metabolism studied by tracer methods. Within 48 hr 98% of the activity was excreted in the urine. Of the radioactivity in the urine 6% was in the form of inorganic sulfate and 6% was in the form of ethereal sulfate. The major portion of the thiourea was excreted unchanged. The radioactive urinary components were studied by one-dimensional filter paper partition chromatography. A 55-fold concentration of radioactivity in the thyroid gland was noted. 17 references.

2049 Absorption of metallic cobalt-60 from a subcutaneous site. M. Nickson, L. F. Lamerton, and W. V. Mayneord. Nature 164, 613(1949) Oct. 8 (Letter to the editor).

In order to determine the behavior of subcutaneously administered cobalt, mature rats were implanted with active and inactive cobalt wire. The wire (0.01 in. diameter) was cut into lengths of about 1 in. and each radioactive length was estimated to contain 24 μc of cobalt-60. When the animals were sacrificed (4 to 14 days later) localized inflammatory reactions were found in all animals implanted with bare cobalt (active or inactive). When gold-covered cobalt wires were used the only tissue reactions were at the open ends of the tubes. Although no attempt was made in these experiments to

BIOLOGY AND MEDICINE (continued)

determine the quantity of cobalt absorbed, tissues which had been near the bare radioactive wire were found to be more active than tissues near the gold-covered cobalt. Similar inflammatory reactions were obtained in a group of rats implanted with active and inactive cobalt disks. It was also shown that bare metallic cobalt-60 can be absorbed from a subcutaneous site and may be found in the adjacent tissues, in the liver, kidneys, remaining parts of the body and excreta. It was concluded that neither cobalt-60 nor its alloys should be used parenterally without prior investigation of possible absorption.

2050 Actions of histamine on the vascular system of the rabbit studied by means of radiosodium. F. Morel and M. Marois. Compt. rend. soc. biol. 143, 464-8(1949) Apr. (in French).

The results of studies utilizing radio-sodium to determine the actions of histamine in the rabbit are presented; the method, techniques and procedure are included. Sodium-24 was injected intravenously in an isotonic solution and measurements of its activity at different intervals of time were made from arterial blood after histamine had been introduced intravenously into the system. The rate of exchange of the sodium across the capillary walls between circulating plasma and interstitial liquid of the entire organism was determined. The results show that there was a considerable diminution of the circulating blood volume during the hypertensive phase, which condition was corrected when the tension fell. The sodium rate of exchange between the plasma and interstitial fluid was not changed during the hypotensive phase of the action of histamine injected intravenously. The volume of extracellular fluids, calculated in the last phase of the curve presented, was not affected by the histamine.

2051 Application of the method of isotopic dilutions to the study of the specificity of the proteins. Georges Schapira, Jean-Claude Dreyfus, and Jacques Kruh. Compt. rend. 228, 1824-6(1949) June (in French).

The method of isotopic dilutions (Rittenberg and Foster, J. Biol. Chem. 133, 737 (1940)) is applied to the problem of qualitative determinations of the specificity of a given substance. A mixture of the the latter and of another substance of the same or neighboring specificity is submitted to a physical or chemical fractionation; if one of the two substances had been previously made radioactive, the fractionation products should show constant activity ratios in the case of similar specificities of the two initial substances. The authors used two hemoglobins, (rabbit and horse), one of which was tagged with radioactive iron; the fractionation consisted of a precipitation of one of the hemoglobins with a solution of mono- and di-potassium phosphate (3.1 M). The method was found to be sufficiently rapid and sensitive.

2052 Artificial radioactivity in biology and medicine. A popular presentation. Traude Bernert. Springer publ., Vienna, 1949. (in German). 83p. 27 diagrams.

This book discusses the physical basis and methodology of radioactive indicators, the application of the indicators to biological problems, and the role of the indicators in diagnosis and therapy. Under the first subject mentioned above, such topics as the definition of the isotopes and their atomic configuration, the methods of determining the most satisfactory indicator for the particular problem, radiographic methods, and the use of stable isotopes as indicators are discussed separately and in detail. Part two explains the role of radio-sodium in determining permeability, the use of P^{32} in following the organic phosphate reactions, radio-iron determinations in the red blood cells, and other allied subjects. Part three discusses the dosage relationships of some of the isotopes, the uses of radioactive penicillin, and the treatment of tumors and blood conditions.

2053 The behavior of labeled iodocasein in human myxedema. C. F. Hamilton, A. Albert, Marschelle H. Power, Samuel F. Haines, and F. Raymond Keating, Jr. J. Clin. Endocrinol. 9, 828-40(1949) Sept.

The present study represents an initial effort to explore the distribution and transformation of calorigenic compounds in the body through the use of compounds labeled with radioiodine I^{131}; radio-iodocasein was synthesized from casein and radioactive I^{131}, and used for these experiments on a

BIOLOGY AND MEDICINE (continued)

myxedematous patient having little or no thyroid function. The iodocasein was shown to correct the signs and symptoms of human myxedema; comparative studies with labeled inorganic iodide (NaI^{131}) during myxedema and euthyroidism indicated that no demonstrable localization occurs in the athyrotic person, nearly all of the iodine being accounted for in the urine and the feces; no transformation of iodide was observed. Concentration of the radioactivity during studies with labeled organic iodine on subjects with myxedema and euthyroidism occurred over the gastrointestinal tract and the liver; high fecal activity and low urinary activity were noted. Iodocasein was rapidly absorbed and degradated, and it was concluded that both iodine and iodocasein were disposed of more rapidly by subjects in a euthyroid state than those in a hypothyroid state. 15 references.

2054 Comparisons of the distribution of radioactive iodine in serum and urine in different levels of thyroid function. Robert H. Williams, Herbert Jaffe, and Beatrice Bernstein. J. Clin. Invest. 28, Part 2, 1222-7(1949) Sept.

Two types of experiments involving the administration of 100 mc tracer doses of radioactive iodine I^{131} administered subcutaneously are described. The first experiment required frequent sampling of the blood and urine over a 24-hr period in order to determine the proportion of isotope present; the second experiment required the conservation of the total urine output over a 24-hr period and a sample of blood taken at the end of that period. Determinations of the radioiodine content were made for all the samples taken after the injections. Patients with thyrotoxicosis, Addison's disease, athyreosis, and euthyroidism were tested. It was confirmed that thyrotoxic patients excrete less of the isotope in the urine than do other groups; the concentration of the total radioiodine and protein bound thyroxine was found to be above normal after 24 hr in these patients, and also in patients with athyreosis, but the ratio of the di-iodotyrosine radioiodine to thyroxine radioiodine was subnormal; the product of the radioiodine in the urine and the inorganic form in the serum was distinctly greater than normal in both groups, individuals with athyreosis demonstrating the higher level. 13 references.

2055 The conversion of S^{35}-homolanthionine to S^{35}-cystine in the rat. Jakob Z. Stekol and Kathryn Weiss. J. Biol. Chem. 179, 67-70(1949) May.

This report describes the results of experiments to determine whether the sulfur of homolanthionine is available for the synthesis of cystine in the rat. Three male rats were used in the experiment; one rat was fed a diet of 0.8 gm of S^{35}-homolantionine/100 gm food, while another rat received unmarked homolanthionine in the same ratio, and the third rat was used as the control; the feeding time was 12 days. The radioactive homolanthionine was prepared from a sample of S^{35}-S-benzylhomocysteine by a previously described method. The rats were killed and their hair was clipped, washed and hydrolyzed separately, and a quantitative precipitation of cysteine was performed, followed by an oxidation of the cysteine to cystine. The isolated cystine was shown to be radioactive, and the conclusion is drawn that the sulfur of homolanthionine was available to the rats for the synthesis of cystine.

2056 Determination of the fate of calcium in the laying hen by means of radiocalcium (Ca^{45}). J. W. T. Spinks, M. R. Berlie, and J. B. O'Neil. Science 110, 332-3(1949) Sept. 30.

Experiments involving the determination of calcium metabolism in laying hens by means of feeding $CaCO_3$ containing Ca^{45} are presented. A hen was fed 1.71 g $CaCO_3$ with an activity of 2×10^6 cpm, and the calcium in the eggs laid subsequently and in the droppings was determined; the total calcium and the percentages of calcium uptake in the shell, white, and yolk at different periods of time were calculated. The recovery of the calcium was at a maximum (29%) in the shell of the second egg and decreased rapidly in the shells of subsequent eggs; a large portion of the calcium was excreted (50%) within 48 hr. A subsequent experiment showed that the percentage uptake of calcium from a given source became relatively constant in about 8 days after the first feeding. It is concluded that the calcium obtained from a single egg in a multiple feeding experiment is a summation of fractions of the calcium fed on many different days.

BIOLOGY AND MEDICINE (continued)

2057 Graphic recording of the concentration of a radioactive product in the body fluids by the aid of a mechanical integrator. Francois Morel and Francois Serrell. Compt. rend. 229, 447-9(1949) Aug. 17 (in French).

The authors suggest a method which can be used to obtain direct and automatic graphic representation of the concentrations of radioactive substances in the blood at the same time these are produced. The method used is similar to one proposed by Reiss et al (Biochem. J. 44, 255(1949)) and consists of making the liquid flow through a plastic tube coiled about a Geiger-Müller counter. The volume of liquid flowing around the counter is small and constant; the measured variations in radioactivity correspond exactly to the variations in concentration of the radioactive element. In an electromagnetic recording device a writing arm is displaced vertically with constant speed and is automatically returned to zero after every 1,000 impulses. The height of each mark corresponds to the time required for 1,000 counts, being in inverse proportion to the concentration. The curve obtained by joining the peaks of all the marks represents the concentration variations as a function of time. Results with this method are identical to those obtained by other methods.

2058 The immunologic reactivity of bovine serum albumin labelled with trace-amounts of radioactive iodine (I^{131}). Herman N. Eisen and Albert S. Keston. J. Immunol. 63, 71-80(1949) Sept.

The present investigation was undertaken to determine whether radioiodine I^{131} could be used to prepare, in vitro, a tagged protein, highly labeled with respect to radioactivity, but so slightly altered structurally that its original immunologic specificity would remain intact; bovine serum albumin was used in the experiments. Two methods of labeling were employed: coupling of p-iodophenyldiazonium chloride to a protein to form an azoprotein; and, direct iodination with the formation of an iodoprotein. The latter labeling proved superior because of its greater stability; carrier-free radioactive iodine could also be used with the latter procedure, thus limiting the amount of iodine used. It was found that the tagged proteins were capable of determining the relative antibody concentrations in antisera of the native protein; the reactions of antisera with tagged bovine serum albumin were indistinguishable from those with the native protein in the quantitative precipitin studies conducted. 19 references.

2059 Influence of adrenalectomy on the distribution of radiophosphorus in various organs of the rat. Joseph Sternberg and Henri Le Bars. Compt. rend. 229, 384-6(1949) Aug. 1 (in French).

An attempt was made to determine whether the removal of the adrenals modifies the distribution of radiophosphorus in the organs of the rat. P^{32} in the form of $Na_2HP^*O_4$ was administered subcutaneously to male rats 48 hr after adrenalectomy, before the animals showed any visible signs of insufficient adrenaline. The speed of circulation and distribution of P^{32} in the organs of the adrenalectomized rats did not differ from that found in controls. The muscle of the adrenalectomized animals after 48 hr did not present notable variations in the concentration of phosphorus and radiophosphorus with respect to the controls. The total amount of P^{32} in the lungs and heart of the adrenalectomized animals was the same as in the controls, but the concentration of P^{32} and the specific activity were perceptibly augmented.

2060 The mechanism of action of phosphoglucomutase and phosphoglyceric acid mutase. Earl W. Sutherland, T. Z. Posternak, and Carl F. Cori. J. Biol. Chem. 179, 501-2(1949) May (Letter to the editor).

When α-glucose-1-phosphate (α-G 1-P) containing C^{14} and P^{32} was incubated with the appropriate enzyme and non-radioactive synthetic α-glucose-1-6-phosphate (α-G-1-6-P) the radioactivity of both the carbon and phosphorus became evenly distributed among the three compounds participating in the reaction. In an analogous manner the mutase which catalyzes the reaction, 3-phosphoglyceric acid (3-P-GA) $\rightleftharpoons$ 2-phosphoglyceric acid (2-P-GA) is activated by catalytic amounts of 2,3-diphosphoglyceric acid (2,3-P-GA) a compound which can be isolated from blood corpuscles; the conversion of 2-P-GA to 3-P-GA was measured polarimetrically. The same mechanism of action for other phosphomutases known to exist is conjectured and proposed.

BIOLOGY AND MEDICINE (continued)

2061 Metabolism of emulsified trilaurin (--C^{14}OO--) and octanoic acid (--C^{14}OO--) by rat tissue slices. R. P. Geyer, L. W. Matthews, and F. J. Stare. J. Biol. Chem. 180, 1037-45(1949) Oct.

The experiments reported here illustrate the ability of slices of various rat tissues to metabolize aerobically carboxyl-labeled trilaurin in an emulsified form and octanoic acid as its sodium salt and describe the preparation of the radioactive compounds. The utilization of the lipids was measured by the amount of radioactivity in the respired carbon dioxide. It was shown that the carboxyl-labeled trilaurin in a finely emulsified form was metabolized by rat kidney, liver, spleen, heart, lung, brain, and skeletal muscle slices; the water-soluble sodium octanoate gave similar results. The metabolism of these substrates proceeded most rapidly during the first 2 hr, but significant oxidation occurred for as long as 6-7 hr in the liver tissue. The relative order of the ability of the various organs to oxidize octanoic acid depended to a certain extent upon the level of substrate present.

2062 A method for continuous graphic recording of radioactive tracer concentrations from various body regions simultaneously. M. Reiss, F. E. Badrick, Jean M. Halkerston, and J. H. White. Biochem. J. 44, 255-6(1949).

A polygraphic device for recording the continuous and simultaneous changes in radioactive tracer concentrations in different regions of the body is described. The internal wiring of a dynatron scaler was modified, so as to allow for impulse reception and recording on either the external or the internal circuit. For recording the impulses coming from different Geiger counters located at various sites on the body, different scalers were employed, each connected with its external counter writer, thus permitting simultaneous recording of fluctuations of tracer concentrations on the kymograph. The method was tested intravenously by injecting rabbits with I^{131} and recording the rate of disappearance of the tracer from the blood; the rate of uptake of the tracer by the thyroid was recorded simultaneously. It was also tested on a human subject and it was determined that very soon after the injection of the tracer into the blood stream, the thyroid counter began to show an increased activity, while changes in the bladder readings occurred later; the gradient of the I^{131} uptake was found to vary considerably in different persons.

2063 Mobilization of radioactive sodium from the gastrocnemius muscle of the dog. Peter W. Stone and William B. Miller, Jr. Proc. Soc. Exptl. Biol. Med. 71, 529-34(1949) Aug.

The study reported here involved the use of radioactive sodium on dogs (1) to determine the role of the lymphatics in the mobilization and removal of intramuscularly injected radioactive sodium, and (2) as a means of qualitatively estimating the radioactive sodium in the blood draining from the injection site. In the lymphatic experiments a 0.1-0.2 cc solution of sodium chloride containing 5-20 μc of Na^{24} was injected into one of the gastrocnemius muscles; dogs were injected with a saline solution containing 7-17 μc in the capillary and venous system experiments. A determination of the sodium content of the thoracic duct indicated that the lymphatic system of the dog's hind extremity does not play a significant role in the mobilization of intramuscularly injected sodium, nor does the radioactive material diffuse along intramuscular planes beyond the region of the injection. A study of the collected blood and the Geiger counter readings from the injection site indicated that sodium can be quantitatively recovered from the femoral vein blood if the collateral venous system of the upper thigh is occluded; the rate of removal of the Na^{24} measured external to the injection site was the same as that determined directly from the blood draining from the muscle.

2064 Proceedings of the Physiological Society 26 March 1949. J. Physiol. (London) 109, 4-16(1949) Sept. 15.

Among the papers presented at the meeting of March 26, 1949, of the Physiological Society was the following: The movements of radioactive sodium during nervous activity, R. D. Keynes. The experiments described employed Na^{24} as a tracer and indicated that the permeability of sodium through nerve membranes increases considerably during activity; support is given to the theory that sodium plays an important role in nerve conduction.

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2065 Proceedings of the Physiological Society 23 April 1949. J. Physiol. (London) 109, 17-23(1949) Sept. 15.

Among the papers presented at the April 23, 1949, Meeting of the Physiological Society was the following: The entry of radioactive phosphorus into the phospholipids of the brain, R. M. C. Dawson. This paper discusses the changes in metabolism of the mouse brain with functional activity; P^{32} was employed in the experiments, and the results indicated that no significant difference occurred with sex or with age in animals over two months old; emotional excitement and electrical stimulation of the brain produced a significant decrease in the rate of phospholipid synthesis.

2066 On the possible utilization of sulfate sulfur by the suckling rat for the synthesis of chondroitin sulfate as indicated by the use of radioactive sulfur. Dominic D. Dziewiatkowski, Ruth E. Benesch, and Reinhold Benesch. J. Biol. Chem. 178, 931-38(1949) Apr. (See also NSA 2-1727).

The experiments described were performed to test the possibility that sulfate of exogenous origin might be able to combine through ester linkages in an animal organism to form compounds like chondroitin sulfate, mucoitin sulfate, heparin and the like and be retained in the tissues for a considerable length of time. The concentration of S^{35}, given as sodium sulfate by an intraperitoneal injection was traced in the knee joint cartilage of suckling rats, and an attempt was made to determine if the S^{35} present was in the form of chondroitin sulfate. The tracer doses of sodium sulfate were 0.1-0.2 mg each; it was found that after 48 hr 20-25% of the S^{35} contained in a 0.1 mg dose of the sulfate was retained; a large amount of the S^{35} retained was present in the cartilage of the knee joints; data indicate that the rate of uptake of the S^{35} may not be markedly different in suckling rats of ages 3 to 9 days. It is proposed on the basis of a partial separation of chondroitin sulfate from the knee joint cartilage, that all of the labeled sulfate may be retained in this form in the articular cartilage.

2067 Plasma and red cell radioiron following intravenous injection. Turpentine abscesses in normal and anemic dogs. C. L. Yuile, C. G. Bly, W. B. Stewart, A. J. Izzo, J. C. Wells, and G. H. Whipple. J. Exptl. Med. 90, 273-82(1949) Oct. 1.

The experiments presented deal with the effects of multiple turpentine abscesses on the utilization of intravenous iron in normal dogs and in dogs rendered anemic and iron-deficient by continued bleeding. Doses of 1.5-4.5 mg of radio-iron (mixture of Fe^{59} and Fe^{55}) were administered intravenously in gelatin. It was observed that a sterile inflammation induced by repeated subcutaneous injections of turpentine in non-anemic dogs with normal iron contents led to a fall in the plasma iron concentration, the development of a moderate anemia, and a marked delay in the uptake by the red blood cells of intravenous radio-iron. Similar periods of inflammation in anemic, iron-deficient dogs on a diet low in iron caused no increase in the degree of anemia and no inhibition of the red blood cell uptake of intravenous radio-iron. The radio-iron, moreover, appeared only in traces in the abscess exudates. The rate of disappearance of a single radio-iron injection was uninfluenced by sterile inflammation in non-anemic or anemic dogs. The impairment of hemoglobin synthesis by sterile inflammations is discussed.

2068 Preliminary data on the fixation of radio-iodine (I^{131}) by the fetal thyroid of the rabbit. A. Jost, F. F. Morel, and M. Marois. Compt. rend. soc. biol. 143, 142-5(1949) Feb. (in French).

The results of experiments on rabbit fetuses to determine the rate of iodine fixation by the thyroids, with the aid of I^{131}, are presented. When I^{131} was injected intraperitoneally into fetuses of various ages it was found that the first detectable iodine uptake appeared in those animals 20 days old; the uptake rate greatly increased with the 22-day old fetuses since at that age the colloid-containing follicles were most numerous; optimal fetal thyroid functioning caused complete I^{131} fixation within an hour after injection. Other experiments demonstrated that decapitation decreases the rate of iodine uptake by the fetal thyroid.

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2069 Radioactive hormones and receptors. Robert Courrier, Alain Horeau, Jean Jacques, Maurice Marois, Francois Morel, and Pierre Süe. Compt. rend. 229, 275-7(1949) July 25 (in French).

Thyroxine made radioactive by labeling with I^{131} and giving for 1/1,000 γ, 40 counts/min, was used to show that the thyroid hormone penetrates selectively into the hypophyseal cells. Six male rabbits with a mean weight of 2 kg received by way of the marginal ear vein 250 γ of radioactive thyroxine/kg of animal. Autopsies performed 2 hr later showed that the ratio of the radioactivity of 1 mg of hypophysis to 1 mg of blood varied from 1:7 to 2:3. Since the hypophysis-blood ratio for KI* and Na*Cl are both 0:5, this indicates that these are extra-cellular elements whereas radioactive thyroxine penetrates into the cells of the gland. Another experiment was carried out using an artificial estrogen, dimethylethylallenolic acid, rendered radioactive by fixing radiobromine in the naphthalene nucleus. The radiobromine was prepared in a cyclotron and consisted of a mixture of two isotopes with half-lives of 4 hr, 4 min, and 34 hr, respectively. At the time of injection into castrated rats, 1 γ of the radioactive estrogen gave 10,000 cpm. Half of the animals received 100 γ of brominated estrogen, and the other half received an equivalent dose of radioactive bromide. No penetration of brominated-estrogen into the hypophysis was observed. This may be given two interpretations: either an insufficient amount of tracer was used, or the radio-bromine becomes detached from the estrogen, and the hormonal function not being marked, it becomes impossible to follow. These results indicate the necessity of using sufficiently large radioactivities.

2070 The rate of conversion of administered inorganic radioactive iodine into protein-bound iodine of plasma as an aid in the evaluation of thyroid function. Dwight E. Clark, Robert H. Moe, and Evelyn E. Adams. Surgery 26, 331-40(1949) Sept.

The present investigation was undertaken to determine the usefulness of the rate of conversion of orally administered inorganic radioactive iodine into protein-bound iodine of the plasma as a clinical guide in the determination of thyroid activity, especially in borderline cases of hyperthyroidism and hypothyroidism. Radio-iodine, I^{131}, was administered orally in doses of 0.5-8 mc to normal patients and those with various thyroid states, hypertension and cardiac disease with elevated basal metabolic rates; blood samples were taken 24 hr later and fractionated; the radioactivity of the plasma proteins was determined after their precipitation. It was found that in the normal individual, 13-42% of the inorganic iodine was converted into protein-bound iodine in the plasma within the 24-hr period; those patients whose rates were 50% or above were considered hyperthyroid cases, and those with rates of 10% or less were classed as hypothyroid cases. Patients with hypertension exhibited normal rates; those with cardiac disease showed a low conversion rate. It is concluded that this method may be of some use as a clinical guide. 15 references.

2071 Studies on the conversion of radioactive leucine to acetoacetate. Minor J. Coon and Samuel Gurin. J. Biol. Chem. 180, 1159-67(1949) Oct.

The results of studies of the metabolism of leucine, tagged with C^{14} in the β and γ positions, in liver slices are presented; the methods of synthesis of the two tagged leucines are included. The results show that the α and γ carbons of the amino acid split off as a 2-carbon intermediate during the incubation process, the intermediate being capable of condensing to form acetoacetate. The administration of the β-labeled amino acid to a phlorhizinized rat, followed by the degradation of the urinary acetoacetate, gave results similar to the findings in vitro. Evidence has been presented that the isopropyl group of leucine is not completely oxidized to carbon dioxide in the liver tissue, and that it does not furnish to an appreciable extent a 2-carbon fragment similar to the one arising from the α and β carbon fractions of the amino acid. 21 references.

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2072 Studies with radioactive iodized fat. I. Preparation of radioactive fat with observations on the absorption of fat following subcutaneous and intraperitoneal injection in dogs. Alexander M. Rutenburg, Arnold M. Seligman, and Jacob Fine. J. Clin. Invest. 28, Part 2, 1105-9(1949) Sept.

Part I includes a method for the preparation of radioactive fat, with the data on the absorption of such fat from the subcutaneous and intraperitoneal spaces, with and without hyaluronidase. Potassium iodide (3.6 g) was dissolved in 6.2 cc of distilled water, to which 1 cc of I^{131} and 2-4 g of potassium iodate had been added; on the addition of 7.2 cc concentrated HCl, $I^{131}Cl$ which had precipitated, was redissolved. Diluted aliquots of this solution were added to a soya oil-ether solution; the ether was driven off and the residual oil was used in subsequent experiments. Ten cc of the radioactive oil were injected subcutaneously into the flank in each of two dogs; just prior to the oil injection, one of these dogs was also given 20 mg of hyaluronidase in 25 cc of saline into the same site. The rate of absorption of the radioactive fat into the circulation was determined by measuring serial blood samples for radioactivity; not more than 0.25% of the total radioactivity injected appeared in the circulation up to 48 hr afterwards. Subsequent experiments involving intraperitoneal or intramuscular injections of radioactive fat at a concentration of 10 cc/kg body weight were also performed; 5-10 mg of hyaluronidase was usually injected just before the administration of the fat. The results were similar to those of the first experiment. It is concluded that absorption of the fat injections was slow whether the fat was administered intraperitoneally or subcutaneously; most of the injected material remained at or near the site of injection, although the site in all cases was massaged after injection. Hyaluronidase was not found to increase the rate of absorption of tagged fat from the subcutaneous or the intramuscular space. 25 references.

2073 Studies with radioactive iodized fat. II. The tissue distribution of emulsified fat following intravenous administration. Alexander M. Rutenburg, Arnold M. Seligman, and Jacob Fine. J. Clin. Invest. 28, Part 2, 1110-16(1949) Sept.

Part two describes the results of the treatment of both mice and dogs with intravenous injections of the radioactive fat emulsions. Twenty-four to thirty hours after the slow intravenous injection of 1.2-4.2 cc/kg body weight of the solution into each of eight dogs, the distribution of the radioactivity among the plasma components was studied by withdrawing and fractionating plasma specimens. Tissue analyses were also performed on the dogs and on mice which had received 0.25 cc intravenous injections via the tail vein. It was found that after an intravenous injection the radioactive solution is lost rapidly from the circulation; approximately 60% of the radioactivity still present in the circulation 24 hr after injection is contained in the lipoid fraction of the plasma and 20% in the ionic iodine fraction. Immediately after injection, the highest concentration of radioactivity in the tissues of dogs appears in the spleen, lung and liver and decreases slowly; radioactivity in mice is highest in the lungs. Iodine is gradually liberated from the iodinated fat and excreted; it is not stored in mesenteric fat depots.

2074 Studies on the revivescence of the thymus. VII. Thymal-pancreatic relationships. Action of insulin on the process of revivescence of the irradiated thymus. Luigi Viale and Cesare Ravazzoni. Arch. E. Maragliano patol. clin. 4, 293-304(1949) Mar.-Apr. (in Italian) (See also NSA 3-1831, 1832).

The authors observed that in guinea pigs whose thymus glands were irradiated with a single dose of 85 r, then treated with insulin for 10 days starting 10 days after irradiation, the revivescence process of the irradiated thymus did not seem to be modified.

2075 Synthesis of nucleic acid and phosphoprotein in normal and cancer tissue slices studied with radio phosphorus. Walter Mann and Janet Gruschow. Proc. Soc. Exptl. Biol. Med. 71, 658-60(1949) Aug.

Radioactive phosphorus in the form of phosphate was used to study the synthesis of total nucleic acid and phosphoprotein in both normal and tumor tissue slices, by measuring the degree of incorporation of the phosphorus under aerobic and anaerobic conditions and in the presence and absence of added

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glucose. Liver and kidney tissue slices from white rats were dried and placed in Krebs-Ringer bicarbonate solution to which had been added P^{32} to the concentration of about 1 μc/ml; 11 normal rats and 9 with transplantable carcinoma 256 were utilized. The nucleic acid and phosphoprotein were separated from the other constituents, dried, weighed, dissolved in alkali, and counted for radioactivity. It was shown that phosphate incorporation into nucleic acid and phosphoprotein of liver, kidney, and tumor tissues shows some dependence on the presence of oxygen; inhibition of the phosphate incorporation by nitrogen and its partial reversal by the addition of glucose suggest that, in tumor tissue at least, glycolysis can also serve as a source of energy for the incorporation.

2076 Tracer studies of nitrogen assimilation in yeast. II. Richard Abrams, E. Hammersten, P. Reichard, and E. Sperber. J. Gen. Physiol. 32, 271-7(1949) Jan. 20.

In the present report N^{15} was used as a tracer to observe the formation of protein and nucleic acid purines in the yeast, Torulopsis utilis. It was shown that there was no measurable incorporation of N in the protein or polynucleotide purine of carbon-starved yeast. When ammonia was added to the nitrogen-starved yeast there was a long lag period before division began during which time the yeast rapidly synthesized protein, this process being accompanied by a turnover of polynucleotide purine; there was no significant dilution of the $N^{15}H^{+}_{4}$ of the medium by ordinary NH^{+}_{4}. When yeast containing N^{15} was allowed to divide and grow in ordinary ammonia, the total amount of N^{15} in the yeast remained constant; the dicarboxylic amino acids were the most diluted, while arginine and nucleic acid guanine were undiluted. 16 references.

2077 Use of Geiger counter for quantitative estimation of phosphorus-32 in histological sections. H. F. Atkinson. Nature 164, 541(1949) Sept. 24 (Letter to the editor).

An apparatus for investigating the distribution of P^{32} in histological sections of human dental enamel is described which is similar to that recently described by Bourne (Nature 163, 923(1949)). A horizontally arranged microscope is used to view scanning holes which have been pierced with a high degree of accuracy. The light source is provided by a low-voltage lamp and a mirror which is mounted on a sliding rod.

2978 Chemical composition of irradiated bone marrow. Albert A. Dietz and Bernhard Steinberg. Arch. Biochem. 23, 222-8(1949) Sept.

The results of analyses of rabbit bone marrow up to 32 days after the animals were irradiated with x-rays, are presented. The rabbits were over four months old at the time of the irradiation. After anesthetization, a dose of 3,000 r of unfiltered x-rays was usually delivered in a field of 380 cm^2 over the legs on the right side of the animals at the rate of 160 r/min. The rest of the body was shielded with lead and, at intervals after the irradiation, the irradiated marrow was compared with marrow from the opposite, non-irradiated side. It was found that the irradiated marrow showed an increase in lipid content and a decrease in water, residue (lipid-free solids), non-protein sulfur fractions, and total lipid and non-protein nitrogen. The changes in composition were most drastic in the marrow normally the most active; a relatively greater amount of water was associated with the residue of the irradiated marrow.

2079 The effect of total body x-radiation, antistine, and pyribenzamine on the phagocytic functions of the reticulo-endothelial system in rabbits injected intravenously with radioactive colloidal gold. Jack Barrow, John L. Tullis, and F. W. Chambers, Jr. Naval Medical Research Institute NM-007-039 Report No. 24, July 25, 1949. 31 p.

The function of phagocytosis by the reticulo-endothelial system (RES) was studied by radiometrically determining the rate of removal from the blood stream of colloidal gold, made radioactive in tracer amounts, injected intravenously into rabbits. The rate of removal was determined in a large group of normal rabbits, in several groups of x-radiated rabbits, and in rabbits previously treated with thorotrast, antistine, pyribenzamine, and histamine. A significant variation in the rate of uptake of

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colloidal gold in otherwise normal animals was noted. The reasons for this are not apparent. Thorotrast given 16 hr previously was found to be capable of retarding almost completely the removal of the colloidal gold from the circulation. This is attributed to the known blockading effect of thorotrast on the RES. At no time following total body x-radiation was the rate of gold sol uptake found to be significantly impaired; it is concluded that if acute exposure to total body ionizing radiation damages the chief function of the RES, phagocytosis, this damage is exceedingly slight and transient. Neither did the antihistamine drugs retard, nor histamine accelerate, the rate of phagocytosis of the gold colloid. No special role of these compounds in the mechanism of phagocytosis can be deduced from these studies. 24 references.

2080 The effect of total body x-radiation on 17-ketosteroid excretion in dogs. G. H. Lawrence. Naval Medical Research Institute NM-007-039 Report No. 22, June 14, 1949. 15p.

Alterations in adrenal cortical function following exposure to x-radiation have been described by various authors. This study was undertaken to follow one aspect of this alteration. Urinary excretion of 17 ketosteroids as assayed by a modified Zimmerman reaction (Callow et al, Biochem J. 32, 1312(1938); Talbot et al, J. Biol. Chem. 132, 545(1940) was followed in 11 dogs which had been exposed to a minimal lethal dose of 1000 kv total body x-radiation. All dogs showed a significant increase at one time between the fifth to twelfth day. The rise was followed by a fall to normal or subnormal levels with a final trend in excretion, to normal ranges by the thirtieth to fortieth day. This excretion pattern is interpreted as indicating an alteration of adrenal cortical and/or testicular activity in these animals. The hormonal excretion pattern is similar to that reported as occurring in the organism's adaptation to other stimuli. Further studies are necessary to establish this concept. 30 references.

2081 Increased metabolic rate in rats after x-irradiation. Leonard B. Kirschner, C. Ladd Prosser, and Henry Quastler. Proc. Soc. Exptl. Biol. Med. 71, 463-7(1949) July.

In order to verify the hypothesis that catabolism is increased by irradiation, the basal metabolism of albino rats was measured after total body exposure to x-rays. The rats were irradiated, two or three at a time, from a 200-kv source with no filter and at a target distance of 55.5 cm, one-half of the dose being delivered from above, and one-half from below the animals; the average tissue dose rate was 40.5 r per min. Twelve rats received 809-972 r, six of which developed severe diarrhea, showed an oxygen consumption elevation of 35% in 24 hr, lost weight rapidly, and died in 3-5 days. The remaining six rats died 9-10 days after irradiation, and two out of eight irradiated with 648 r also died at this time; all showed an oxygen elevation of about 58%. The six rats which survived the 648 r irradiation, showed an average increase in oxygen consumption of 32% during the first seven days, and a less pronounced increase over a period of 16 days after the irradiation. Doses of 54-432 r were given to other groups of rats and caused an average increase of about 8.5%. In all of the experiments, the increased metabolism did not coincide with weight loss either in time course or in dose dependence.

2082 Mutants produced by x-irradiation of spores of chaetomium globosum and a comparison with those produced by ultraviolet irradiation. J. M. Ford and D. P. Kirwan. J. Gen. Physiol. 32, 647-53(1949) July 20.

Detailed experiments on the relation between the dose in roentgens and the percentage lethal mutants produced by x-rays have been made. Approximately 4,000 spores of the fungus Chaetomium globosum were spread on a circular area of celluoid in each experiment, and were irradiated with roentgen dosages of 9,400-329,000 r. The colonies were then obtained by the single spore and the dilution plate techniques; the single spores were examined daily for germination and lethality. It was found that the production of the mutants from x-rays is consistent with five quantum hits, and from the form of the mutant curves, it is noted that more quantum hits are required than the two quantum hits consistent with the ultraviolet experiments. In the case of the macroscopic mutants produced by x-rays, the most striking feature is the scarcity of the mutant K which is produced selectively and in large numbers by ultraviolet radiations. The results obtained suggest that the production of K is limited to a small region of the electromagnetic spectrum.

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2083 On the relationships between vitamins and the thymus. I. The thymus and vitamin A. D. Scopinaro and L. Viale. Arch. E. Maragliano patol. clin. 3, 655-60(1948) May-June (in Italian).

The first part of a systematic study of the relation of vitamins to the thymus is described. The present experiments were carried out on 10 guinea pigs, half male and half female, in which the thymus was exposed by incision of the skin and cervical fascia, and subsequently irradiated with a single dose of 85 r. Between the 10th and 20th day after irradiation there was administered parenterally to each animal 5,000 I.U. (International Units) of vitamin A. A second group of guinea pigs subjected to the same treatment, with the exception of the administration of vitamin A, served as controls. Both groups of animals were sacrificed on the 30th day following irradiation, and the thymus, thyroids, adrenals, gonads, and hypophysis were removed and studied histologically. It was observed that generally the revivescence process was almost the same in the controls as in the treated animals. In the treated animals, however, it was noted that constant necrotic lesions appeared in the medullary portion of the thymus.

2084 On the relationships between vitamins and the thymus. II. The thymus and vitamin B_1. D. Scopinaro and L. Viale. Arch. E. Maragliano patol. clin. 3, 661-7(1948) May-June (in Italian).

The authors observed that treatment with vitamin B_1 did not seem to modify the revivescence process in the thymus of guinea pigs when these glands were subjected to single irradiations of 85 r. It was further observed that some necrotic lesions were localized in the medullary portion of the thymus.

2085 New experimental researches on restoration in radiobiology. Paul Lamarque and Pierre Bétoulieres. Compt. rend. 229, 308-10(1949) July 25 (in French).

Eggs of Bombyx Mori were subjected to irradiation with x-rays emitted under 54 kv, giving 3,000 r/min and with γ rays from radium tubes filtered by 0.5 mm platinum, in order to study the restoration process following the irradiation. Exactly identical curves were obtained when the eggs were placed in incubation directly after the irradiation (3,000 r/min) and when they were placed on ice for 24 hr after the administration of the irradiation before placing them in the incubator. Eggs irradiated by radium (13 r/min) while in the refrigerator gave a response exactly identical to the above. These results show the perfect independence of the effect observed toward the quality of the radiation used. Eggs irradiated with the same radium source but at 21°C showed an important amount of restoration. With radiations effected in the refrigerator there was a slight restoration which indicates that, in reality, the biologic activity of the eggs is not totally abolished but simply markedly reduced by the cold.

2086 The sequence of cellular response to injury in mice exposed to 1100 r total body x-radiation. Jack Barrow and John L. Tullis. Naval Medical Research Institute NM-007-039 Report No. 23, July 6, 1949. 45p.

Following a single lethal dose (100% in approximately 96 hr) of 1100 r total body x-radiation, 880 mice were killed 10 at a time at hourly intervals. Microscopic observations of spleen, mesenteric lymph nodes, bone marrow, intestines, and testis were made to determine the sequence of cellular response to the injury. Fragmentation and lysis of lymphoid elements were well established one hour after exposure. The extent and rapidity of progression of destruction were of equal intensity in the lymphoid elements in the spleen, mesenteric lymph nodes, and lymphoid aggregations in the intestinal wall. The erythropoietic elements also were almost as radiosensitive as the lymphoid tissues. Slightly less radiosensitive were the myelopoietic and megakaryocytic elements in that order. The reticulo-endothelial cells remained morphologically intact. In the testis the spermatogonia disappeared by 66 hr, but the spermatocytes and particularly the spermia and Sertoli cells were more radioresistant. The crypt epithelium of the small intestine and to a lesser extent the basal portions of the glands of the large intestine were damaged early, but repair of these organs was accomplished by the 85th hour. 16 references.

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2087 Some effects of P^{32} on the development of drosophila. T. J. Arnason, R. L. Irwin, and J. W. T. Spinks. Can. J. Research 27, 186-94(1949) Aug.

The results of experiments determining the tolerance rate of Drosophila melanogaster eggs for solutions of P^{32} are presented. Concentrations of 0-1.3 rutherford (rd) were used in the series of tests conducted; the eggs were transferred into 5 cc portions of the radio-phosphorus solutions and the larvae and pupae mortalities were observed. It was determined that a dosage of 1.30 rd/ml prevented transformation from the larval to the pupal stage; no adults emerged from solutions containing concentrations of 0.65 rd/ml or higher. The calculated concentration of P^{32} expected to produce 50% mortality up to the adult stage was 0.120 rd/ml. It was noted that 3 out of 132 x-chromosomes from males reared in a medium having an initial concentration of 0.0325 rd/ml carried new recessive genes. 8 references.

2088 Treatment of radio-lesions caused by the atomic explosion. P. E. Genaud. Semaine Hopitaux Paris 25, 2391-5(1949) July 30 (in French).

The author briefly discusses some secondary radiation effects on the hematopoietic organs, the digestive tract, the epidermis and the gonads; the hemorrhagic syndrome is described. The treatment of internal radiation by the specific therapy necessary for each type of case is discussed in detail. The treatments suggested are: oxygen therapy and antihistamines; toluidine blue and protamine sulfate for hyperheparinemia; transfusions for thrombopenia; rutin for cases of capillary fragility; and penicillin for infection. The importance of a regulated diet, mental and physical relaxation, and general care is also indicated.

2089 Decontamination of radioactive waste air. I. R. Philip Hammond. AECD-2711, nd. Decl. Oct. 3, 1949. 20p.

Contaminated waste air has been treated with a baffle-plate scrubbing tower with 42 plates in three stages. The air was sampled for activity before and after each stage and the effect of several process variables investigated. With only 6 plates per stage in use, the efficiency for plain cold water washing was 99.6% or better, and was 99.92% for the "cloud chamber" mode of operation which utilized fogging on radioactive particles to increase the size. Some data on particle size and preliminary engineering figures are given.

2090 Radioactive decontamination properties of laboratory surfaces. I. Glass, stainless steel, and lead. Paul C. Tompkins and Oscar M. Bizzell. AECU-551(ORNL-381), nd. 38p.

One of the major problems to be faced in the construction of radiochemical facilities is the selection of structural materials and surface coatings which permit ready cleaning. The following requirements for a decontaminable surface have become accepted among Atomic Energy Commission workers: (1) smooth and nonporous (minimum of adsorption area and penetration), (2) nonionic in character (minimum exchange), (3) resistant to corrosion by acids, alkalis, and organic solvents, and (4) resistant to heat. These are the major criteria which relate to the properties of the materials themselves. Preliminary studies are reported on the decontamination of glass, polished and unpolished stainless steels, and lead. These experiments have led to the development of tests by which the suitability of different materials and cleaning reagents for use in laboratories working with P^{32}, Ba^{140}, and I^{131} have been estimated. A "standard" reagent has been selected for each of these contaminants on the basis of high decontamination efficiency for each of the 4 materials. The degree of decontamination necessary in order to work safely at various levels of activity is discussed. 15 references.

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2091 Radioactive decontamination properties of laboratory surfaces. II. Paints, plastics and floor materials. Paul C. Tompkins, Oscar M. Bizzell, and Clyde D. Watson. AECU-552 (ORNL-382), nd. 35p.

The susceptibility of various paints, plastics, and floor materials to contamination and their subsequent ease of decontamination have been determined by standard empirical tests previously developed for decontamination of P^{32}, Ba^{140}, and I^{131}. The probable usefulness of these materials in facilities handling radioactive materials are further indicated by chemical resistance tests with common laboratory reagents. It is concluded that some of the materials tested may be used to advantage in place of glass, stainless steel, or lead for many common functions, and that they may often be cleaned by mild reagents, such as detergents. The combination of the contaminating conditions, the surface material, and the cleaning reagent are interdependent variables which lead to a high degree of specificity in cleaning efficiency.

2092 Isotopes in biology and medicine. Uses and radiation hazards. E. E. Painter. Am. Practitioner 4, 34-7(1949) Sept.

A discussion is presented on the uses and hazards of isotopes in biology and medicine; the threshold dosages for a variety of effects in certain animals are noted briefly. Such radioactive tracers as Fe^{55}, Fe^{59}, P^{32}, C^{13}, C^{11}, C^{14}, S^{35}, and I^{131} are mentioned as therapeutic agents in the treatment of polycythemia vera, chronic leukemias, some types of skin abnormalities, cancer, and Hodgkin's disease. Such dangers as the irreversibility of the damage caused by the administration of too high dosages and the production of the radiation syndrome are discussed; the syndrome is comprised of four stages, the initial shock, acute, subacute, and chronic. Radiation dosages of 25-200 r are described in connection with the production of lymphopenia, granulocytopenia, anemia absence of reticulocytes, reduction in blood pressure, and other effects in dogs, rabbits, and rats. The tolerance levels for isotopes and for x-radiations are described.

2093 Rules and procedures for radiological safety. Radiological safety committee. Naval Radiological Defense Laboratory Final Report, AD-136(H), Apr., 1949. 48p. (See also NSA 3-1836).

This manual is divided into two parts. Section I consists of general rules and procedures concerning radiological hazards; Section II contains a glossary of terms, and specific information on various procedures pertaining to handling radioactive materials.

2094 Safety factors for radium-containing static eliminators. K. E. Corrigan, H. S. Hayden, and J. O. Reed. J. Michigan State Med. Soc. 48, 1279-82(1949) Oct.

The radiation hazards encountered with the use of radium-containing static eliminators are discussed, and some safety factors for the control of these factors are described. The character of α, β, and γ radiations and the special dangers consequent with the use of each type are outlined. It was found that in the instruments tested and described here (mostly used on presses) the danger from γ radiation was usually minimal, but the danger from β ray contamination was often serious, since the radiations at certain working distances exceeded the tolerance limit of 0.1 rep/day. For the conditions encountered in this study it was determined that a distance of 60 in. was necessary to insure safety against β radiation. The dangers encountered when radon gas escapes from the radium-containing bar are described, and it is pointed out that both instrument efficiency and safety decrease with radon leakage; danger is rapidly increased by improper circulation in the area. The length of exposure, path and distance of operator from the radiation source, the number of instruments in the immediate area and the condition of the eliminators are critical factors to consider in determining the most efficient safety measures.

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2095 Standard safety requirements; safety regulation no. 3. U. S. Atomic Energy Commission, Apr. 28, 1947. 339p. (M-4408).

It is essential to the efficiency of all activities and operations of the U. S. Atomic Energy Commission and the protection of all personnel, equipment, property, and the general public that every practical means be utilized by management and supervision to eliminate or control all accident, fire, and health hazards. To assist in eliminating or controlling these hazards, and to establish a basis for standard performance, the Atomic Energy Commission Safety Requirements have been prepared. The Requirements include all applicable provisions of safety regulations issued by the Manhattan District previous to January 1, 1947, and therefore supersede them. Applicable federal, state, and local laws, codes, and ordinances shall be observed. The Requirements apply to all Government activities of the Atomic Energy Commission, and to activities of contractors or licensees whose accident experience, safety activities, or program is of concern to the Government, or when the contractors or licensees are obligated to comply with pertinent standardized requirements for the protection of employees, property, and the public. Installations in a standby status are included. The requirements have been prepared for use of management, safety engineers, and supervision in discharging their safety responsibilities. They are not intended for use as an employee handbook. The Requirements are supplemented by specific safety codes of nationally recognized authorities, which shall be followed; in instances where they differ, the Requirements shall apply.

The Requirements are presented in the following parts: I. Plant design and layout; II. Production, maintenance, construction, and demolition; III. Permanent equipment and facilities. IV. Guarding and operating machinery; V. Materials handling and storage; VI. Electrical hazards; VII. Chemical hazards; VIII. Fire protection and prevention; IX. Flammable liquids; X. Hand and portable power tools; XI. Motor vehicle operations; XII. Personal protective equipment; XIII. Industrial hygiene; XIV. Radioactive substances and associated hazards; XV. Construction and materials handling equipment; XVI. Organization and program. The following appendixes are included: quantity-distance table for explosives; American table of distances; safe working load in pounds for single new sling ropes and chains; table of common hazardous chemicals; 42-page bibliography.

2096 What are the sources of protection against radiations? M. H. Faes. Rev. questions sci. 10, 333-60(1949) July 20 (in French).

The types of dangerous radiations, their effects on living tissues and the measurement of dosage are summarized briefly preliminary to a discussion of the characteristics (energy, range, biological effects) of the various radiations and the associated shielding requirements. The methods of controlling the intensity of the radiations received by personnel by physical means (such as photographic plates) and by biological means (such as white cell counts) are also treated briefly.

2097 Beta ray burns of human skin. Norman P. Knowlton, Jr., Edgar Leifer, John R. Hogness, Louis H. Hempelmann, Loren F. Blaney, Dan C. Gill, William R. Oakes, and Charles L. Shafer. J. Am. Med. Assoc. 141, 239-46(1949) Sept. 24.

Four cases of β-ray burns of the hands are reported, and the methods of treatment are presented. Estimates indicate that the men received 3,000-16,000 rep (roentgen equivalent physical) to the outer surface of the skin. The β-ray dosages were approximately 300-1,600 rep at 3 mm below the surface and 30-160 rep at a depth of 6 mm. Since there was little evidence that whole body irradiation exceeded 15 r of γ rays in any case, it is assumed that the whole body exposure had little effect on the radiation effects on the hands. The clinical response to the irradiation consisted of four phases: a tingling and itching at the time of exposure, followed closely by a slight erythema and edema, lasting two to three days; a latent, asymptomatic period of three to five days; a secondary erythema, soon followed by vesicle and bulla formation, the vesicles drying and desquamating within three weeks, leaving a new layer of epithelium; and, a chronic phase characterized by atrophic epithelium and loss of secondary epidermal structure. The only significant hematologic findings were a neutrophilia, an increased sedimentation rate, and increase in the number of refractive granules in the cytoplasm and a low grade of reticulocytosis. The treatment was local and consisted of routine burn therapy with accessory chilling,

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surgical debridement and skin grafting. Rutin, a high protein diet, multiple vitamins and parenteral penicillin were also given. The results are incomplete at this time.

2098 Hematological observations in the atom bomb sufferers in Hiroshima city one year after the bombing (second report). T. Kikuchi, et al. Kyoto Imperial University. nd. 11p. (NP-305).

Hematological observations were made of atomic bomb sufferers (510 cases) one year after the bombing and of healthy Japanese (173 cases) as controls in Hiroshima city, with results as follows: Red blood cell counts were less than 4 million in 71.7% of the sufferers and in 61.8% of the controls. Color index over 1.21 was found in 50.6% of the sufferers and in 8.8% of the controls. In white blood cell count, there was no case under 3000 in 1 cmm of blood in the controls; and the counts under 4000 were found in 14.2% of the sufferers (counts under 3000 in 2.1%) and in 3.5% of the controls. In differential count of leukocytes (eosinophils, neutrophils, lymphocytes, monocytes, and plasma cells) and Sugiyama's mean nuclear lobes of neutrophil leukocytes, there were no remarkable differences in both cases; but the curve of neutrophil leukocyte count in the sufferers shifted to lower percentage than that of controls and in the curve of lymphocyte count, this relation was contrary. Blood platelet count was under 90,000 in 28.9% of the sufferers and in 14.9% of the controls. Bleeding time was almost normal in both cases, but the cases with bleeding time over 5 min were found in 4.9% of the sufferers and in 5.2% of the controls. The data are tabulated.

2099 A new drug in the treatment of radiation sickness. John W. Beeler, Jan H. Tillisch, and Walter C. Popp. Proc. Staff Meetings Mayo Clinic 24, 477-83(1949) Sept. 14.

A description of a new drug, dramamine (β-dimethylaminoethylbenzohydryl ether 8-chlorotheophyllinate) for the treatment of radiation sickness is presented; the similarity between the symptoms of motion and radiation sickness suggested the use of dramamine for the latter. Excellent results were obtained in 25% of the 82 cases treated, while good results were shown in 53%; maximal effectiveness was achieved when 100 mg of the drug was given 30-60 min before the radiation treatment and repeated 1.5 hr and 4.5 hr after treatment, for a total dosage of 300 mg. One or more of the side reactions such as drowsiness, "bad taste," paresthesias, and nausea occurred in about 30% of the cases. It is concluded that a combination of dramamine and pyroxidine should be of valuable therapeutic aid in the control of radiation sickness, especially in severe cases.

2100 Observation on both the blood picture and bone-marrow in atomic bomb sufferers in Nagasaki with special reference to Nishiyama district. R. Ishigami, T. Kikuchi, M. Fukase, Y. Yamasoba, and T. Sawada. nd. 24p. (NP-304).

Studies were made of the blood picture (173 cases) and bone-marrow (11 cases) in atomic bomb victims within a radius of 1 kilometer from the bombing center and in the districts, Nishiyama and Motohara Mura. Blood cell data are tabulated.

2101 The radioactivity of the atomic bomb from the medical point of view. Masanori Nakaidzumi. Tokyo Imperial University. nd. 10p. (NP-302).

The radiations which hit the human body were the following: neutrons and γ rays in the air (including the primary neutrons and γ rays from atomic bomb and γ rays produced by the reaction between neutrons and nitrogen nuclei in the air), the radioactivities of the tissues of the human body and the soil resulting from the bombardment of neutrons (β and γ rays), and the fission fragments which fell on the ground (β and γ rays), etc. These all acted together, and the significance of each is complicated. Moreover, the scattering of γ rays by the buildings differed very much according to the type of building and its location. So the total dose received by each person may have been different even when at the same distance from the explosion center or in the same building. The radiation intensity does not always decrease according to the inverse square law. Therefore, the factors affecting the total dose of radiation on the human body are very complicated and not easily calculated. In the estimation of total dose by clinical symptoms, epilation is a rather accurate indication. However, the effect of

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protection by shelter, etc., should be considered and its effect on the appearance of symptoms should be decided statistically. From the incidence of epilation the dose which was given to the human body can be estimated. Assuming the head epilation dose to have been 1000 r within 2 km, where 90% of all patients with epilation were located, it is estimated that the dose directly beneath the explosion center was from 10,000 to 15,000 r. This also assumes explosion center to be 550 meters above the ground and the radiant rays to decay by the inverse square law. Protection from the radiant rays of the atomic bomb afforded by caves, concrete walls, and building structures is discussed.

2102 Report of hematological observations in the atomic bomb sufferers in Nagasaki city one year and 4 months after the bombing. T. Kikuchi, G. Wakisaka, T. Yoda, H. Yamada, and K. Miki. Kyoto Imperial University. nd. 12p. (NP-306).

Conclusions and tables of results of hematological examinations of 172 atomic bomb sufferers and 45 controls (healthy citizens who were not in Nagasaki city at the time of the bombing) are presented. It is concluded that the atomic bomb sufferers in Nagasaki city have returned to normal in the majority of cases, but there are still a few cases with anemia, leukopenia, thrombopenia, and prolongation of bleeding time.

2103 Can the defense mechanism of the body be influenced by roentgen irradiation? Report on a preliminary clinical investigation of the plasma or serum protein pattern in rheumatoid arthritis. H. Ney. Ann. Rheumatic Diseases 8, 191-204(1949) Sept.

An investigation is reported on nine advanced and resistent cases of rheumatoid arthritis treated with wide-field, soft x-ray irradiation. The cases were all apparently similar clinically (except for degree of severity), but low serum albumins and high globulins were found in six, and nearly normal values in the other three. In all nine cases the wide-field treatment was carried out with a Philips Contact Therapy machine, operating at 55 kv, with no additional filtration and at a focal distance of 56 cm. The doses were administered once weekly and were 5-50 r; roughly 1/3 of the body was involved in the irradiation at each session. Following the treatment, the six case groups responded favorably with clinical improvement and a return of the albumin-globulin pattern to normal. Of the remaining three cases, two showed no clinical improvement and unfavorable movements in the albumin-globulin pattern; the third (borderline case) improved belatedly and so far only for a short period, both clinically and in the protein pattern. Functional liver tests in the six responding cases revealed no abnormality, but definite abnormality was found in the two non-responding cases and slight abnormality in the remaining case. It is suggested that: the serum albumin-globulin pattern is an unspecific but reliable indicator of the body's reactive state; soft, wide-field x-ray irradiation can influence a pathological albumin-globulin pattern, at least in cases of rheumatoid arthritis; a return to more normal albumin-globulin levels is followed by clinical improvement in rheumatoid arthritis; and an adverse shift of the albumin-globulin pattern does not necessarily signal an imminent flare-up of the rheumatoid arthritis since such a shift may be caused by an intercurrent disease, without manifestation of a relapse in the rheumatoid arthritis.

2104 Cancer of the lung. Review of a thousand cases. George A. Mason. Lancet 257, 587-91 (1949) Oct. 1.

The etiology, pathology, diagnosis, and treatment of carcinoma of the lungs are discussed, and the results of 1,000 cases are presented. The main method of treatment for these cases was surgery, but for those patients who declined an operation or were unsuited for it, radiation therapy was given; x-rays were delivered in a radical course over a period of 5-6 weeks, the total being about 4,500-5,500 r; the radiations were given to 4-5 fields (lateral, anterior, and posterior). Palliative radiation therapy consisted of the administration of 2,500-3,000 r over about three weeks. Great symptomatic improvement was noted in a large number of cases after treatment, but for the most part the improvement was short-lived. Out of 445 patients treated 42 patients are alive after periods ranging from 5 months to 5.5 years; this includes two out of 113 alive for 5 years; the results are less favorable than those obtained with the pneumonectomy method.

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2105 The cytology of neoplasms of the female genital apparatus before and after treatment with radium, studied by the method of apposition. Mario Bianchi. Tumori 22, 82-105(1948) May-June (in Italian).

Normal and malignant cells from adjacent regions of the female genital apparatus were studied cytologically and compared for the modification of their characteristics before and after the administration of radium therapy; cells from patients with nonmalignant diseases were also studied. Doses of 10.2-82 mcd of radium were administered; it was shown that small doses caused extreme cellular fragility, the cells becoming stretched and losing their normal characteristics, while doses larger than 30 mcd augmented cytoplasmic vacuolization. It is stated that a single specific and constant characteristic of the malignant neoplastic cell is not always present, but enough modifications are usually observable to distinguish the malignant from the normal cell. Radium causes a degenerative and destructive type of change in the neoplastic cells which are more sensitive than normal cells to the radiations. 45 references.

2106 A decade of experimentation in the plesio-roentgen therapy of tumors of the skin and the mucosa. C. Porta. Tumori 22, 119-29(1948) May-June (in Italian).

The results of the treatment of cutaneous and mucosal tumors with plesio-roentgen therapy are described. Most of the cases were treated with 6,000 r in fractionated doses of 500-600 r; in cases of melanoblastoma up to 10,000 r was given in one series. The contact radiation method consisted of irradiation with a 55-kv source at a focal distance of 5 cm and through a 0.2 mm Cu filter. Of the 605 cases treated with this method 54% were cured and of 189 cases, 82% were controlled. This method is advantageous for the favorable treatment of melanoblastoma; the results vary according to the diagnosis and technique. 31 references.

2107 The leukemias (present position of radiotherapy). P. Marquès and P. Bétoulières. J. Radiol. Electrol. 30, 417-46(1949) (in French).

This report discusses the clinical and therapeutic problems connected with the leukemias and compares the radiotherapeutic method with other methods. Hematopoiesis and the actions of radiations on the blood and the hematopoietic organs are described. The differences in blood reactions to whole-body radiations and small field doses, single and fractionated doses, and small and large irradiation doses are pointed out; after massive whole-body irradiation a typical hemorrhagic syndrome appears and death follows. Three types of radiation therapy are discussed, local roentgen therapy, total roentgen therapy (whole-body irradiation), and therapy involving the use of natural and artificial radioactive substances; the local therapy is directed to the ganglia or to the osseous structures (sternum, epiphyses, etc.) and is administered either in a small field at a total dose level of 800-1,000 μ, or in a large field in doses of 150-300 r until 800-1,200 r is reached. Much smaller doses, 10-25 r, are administered when the whole-body irradiation method is used, the total dose seldom exceeding 250 r. The effective doses for radium, thorium-x, radio-phosphorus, and radio-sodium are included, and the results of the treatment of groups of patients with urethane and massive transfusions are given. The statistics from 90 cases of myelocytic origin and 28 cases of lymphocytic origin indicate that radiotherapy is generally still the method of choice (chronic myeloid leukemia responds most satisfactorily to this type of treatment); but none of the methods discussed provide other than primarily a palliative form of therapy. The authors call attention to a complication arising with the use of the present powerful agents: the leukemia syndrome may be eliminated, but a syndrome of medullar aplasia is frequently formed as a result. Adequate treatment of this complication is being investigated. 220 references.

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2108 1949 year book of radiology. Fred J. Hodges, John F. Holt, and Isadore Lampe, eds. Chicago, Year Book Publ., Inc., 1949. 453p.

This book brings together numerous articles which exemplify current trends of thinking and practice in the field of radiology. The subject material is treated comprehensively under two main headings, diagnosis and radiation therapy. Under the latter heading such subjects as the radiation therapy necessary for the treatment of a variety of diseases of the female genitalia, the head and neck, the skin and the breast are discussed in detail. Time-intensity factors, tissue developments in rats exposed to P^{32}, effects of small doses of fast neutrons on mice and other related subjects are discussed under the topic heading of radiation biology. 393 figures, plates, and diagrams are included.

2109 Physical and biological basis of betatron therapy. Gerhard Schubert. Ärztliche Forschung 3, 377-86(1949) Aug. 10 (in German).

An apparatus for the emission of electrons, with energies up to 6 million v and which can penetrate tissue up to 2 cm in depth, is described. The radio-therapeutic value of the fast electrons (β and cathode rays) has its physiological foundation in the fact that the production of energy is greater at a certain depth than at the surface of the tissue. It was found in experiments on a variety of organisms that, in general, the fast electron radiations were of lower efficacy than rays generated by 200-kv machines, but the total qualitative effect seemed to be greater; after an irradiation of 400 r of Ehrlich's carcinoma of the mouse, a far greater prolongation of life was observed with the fast electron application, than with x-rays. The differences between these two types of irradiation may be explained by variations in the degree of ionization and the relative frequency of greater or smaller groups of ionization. 37 references.

2110 Radioactive materials and their medical uses. S. B. Osborn. Am. J. Pharm. 121, 307-18 (1949) Aug.

A similar article by the author was published in Pharm. J. 162, 289-91(1949) Apr. 16. It was listed in Nuclear Science Abstracts as abstract No. 3-67.

2111 Radium treatment of prostatic hypertrophy. Raymond Darget. J. Intern. Coll. Surgeons 12, 666-9(1949) Sept.-Oct.

A type of radium treatment for cases of hypertrophy of the prostate gland is described, and 11 cases are presented. The technique consists of the introduction through a cystostomy opening of radium-bearing needles into the vesicle neck; the needles are anchored in place with silk and silver wire. Of the 11 patients treated by this method, all responded to the treatment, which in some cases involved endoscopic resection. Indications for the use of this method were the frail condition of the patient (poor surgical risk) and the possibility of a degenerating condition. There was no evidence of urethral damage in the form of sclerosis or stenosis from the radiation treatment; the potency of the ejaculatory duct was preserved. The author believes that the method of treatment will be found extremely valuable because of its simplicity and effectiveness.

2112 The treatment of bursitis and peritendinitis calcarea of the shoulder joint by roentgen therapy. Martin S. Abel and Irving I. Lomhoff. Permanente Foundation Med. Bull. 7, 90-93(1949) July.

One hundred and thirty-four patients with bursitis and peritendinitis were treated by a deep roentgen ray method consisting of radiations from a 200-kv machine filtered by 0.5 mm Cu and 1 mm Al delivered at a target distance of 50 cm. The technique was almost uniform, since 115 of the cases received 800-1,200 r in a period of 10-21 days, on alternate days with single doses of 150-200 r. The results of the therapy have been analyzed as regards the duration of the illness and the technique of treatment. Of the entire group, 56% of the patients showed marked improvement or complete relief of their symptoms, and 21% showed moderate improvement.

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2113 The treatment of exophthalmic goiter with radioiodine. Mavis P. Kelsey, Samuel F. Haines, and F. Raymond Keating. Postgraduate Medicine 6, 263-73(1949) Oct.

The long-range results of the treatment of exophthalmic goiter with radioiodine I^{131}, are reported; in 55 of the 69 cases discussed, the patients were followed from 4 to 24 months after treatment. A dose of 15,000-30,000 roentgen equivalents was usually given. In 51 out of the 55 cases treated and followed up there was a remission of the hyperthyroidism; the remission was evidenced by the disappearance of all the symptoms and the reduction of the basal metabolic rate to +15% or lower. In 6 of these 51 cases, a recurrence was observed 3-12 months after the remission, and in 15 of the 51 cases myxedema developed. The total dose delivered in these cases was 2,600-20,000 μc and the average total dose was 8,000 μc. Some dangers to the patients and to the physician which may arise with the use of radioiodine are outlined. It is concluded that thyroidectomy after suitable preparation is still the treatment of choice for ordinary uncomplicated exophthalmic goiter. 31 references.

2114 Use of radium in treatment of hypertrophic lymphoid tissue in the nasopharynx. Charles H. Dow. Arch. Otolaryngol. 50, 417-28(1949) Oct.

Radium therapy was used in the treatment of 74 cases of hypertrophic lymphoid tissue formation in the nasopharynx following adenoidectomy. Forty-one patients were treated by placing the monel metal applicators containing 50 mg of radium sulfate to each side of the nasopharynx for 8.5 min; of these 35 were given three treatments at two week intervals; six patients did not complete the series. Thirty-three patients were treated by placing the applicator to each side of the nasopharynx for 12 min; of these 23 were given treatments at two-week intervals; the other patients did not complete their treatments. It was found that the longer treatment removed the lymphoid tissue safely and more effectively; the β rays from the radium stopped the cellular mitosis at the time of treatment.

2115 What lessons can we obtain from the failures of contact roentgen therapy on cutaneous epitheliomas? P. Chatton. J. Radiol. Electrol. 30, 251-60(1949) (in French).

A report is given of 137 cases of epithelioma of the skin and the results of contact roentgen therapy. The epitheliomas were located on the face, scalp, trunk, legs, and arms and were spino- and baso-cellular, or mixed types. Several ranges of doses were given for each type of epithelioma and anatomical location. The results are treated separately. The dosages generally consisted of radiations of 3,000-25,000 r delivered by the Van der Plaats method, by a variation of the Van der Plaats method, or by the fractionated method of Chaoul over a period of time. Radio-necrosis occurred in a small number of cases; non-sterilizations and recurrences were also observed. The cases were treated by one or multiple field irradiations, and the results indicate that the radiations should be administered to the tumor area plus a margin of peripheral tissue surrounding the tumor in a lethal amount. The fractionated method of Chaoul involving filtration of the radiations is considered to be necessary for the proper treatment of the epitheliomas requiring strong radiations, since it prevents radio-necrosis, and lessens other sequelae.

CHEMISTRY

2116 The dissociation constant of radium citrate measured by the ion exchange method. Jack Schubert, Edwin R. Russell, and Lawrence S. Myers. Jr. AECU-542(UAC-132), nd. 4p.

The first measurement of the dissociation constant of a complex ion of radium, and a revised formulation of the equations used for calculating dissociation constants from ion exchange equilibria are reported. The dissociation constant of radium citrate was measured at 25° ± 1°C in a solution 0.16 M in Na^+, and at a pH of 7.2–7.5. The dissociation constant for the complex ion $Ra(Cit^{-3})^-$ was calculated to be $9.97 \pm .91 \times 10^{-3}$. Thus, as expected from electrostatic considerations, radium forms the weakest citrate complex of the alkaline earths.

CHEMISTRY (continued)

2117 [Final Report on flame sprayed coating of polyethylene for large concrete surfaces to resist a mixture of methyl ethyl ketone and 10% nitric acid.] Bernard Goldberg. AECU-572 (M-4398), Sept. 6, 1949. 6p.

Results are reported for the following investigations: effect of mesh size of polyethylene powder; practical methods of preparation of concrete surfaces before spraying; means of lightening of color of polyethylene; means for patching blisters and pinholes in flame sprayed polyethylene coatings; procedures for spraying coatings; means of obtaining fine mesh polyethylene; combinations of different plastics for coatings; effect of molecular weight of polyethylene. The construction of test facilities and of concrete tanks are discussed briefly.

2118 The specific rotation of yeast adenylic acid in anhydrous formamide. David Lipkin and George C. McElheny. AECU-581, nd. 5p. Proposed for publication in J. Am. Chem. Soc.

Yields of brucine adenylate obtained from samples of commercial yeast adenylic acid by precipitation under standard conditions varied markedly. This was surprising in view of the fact that the nitrogen and phosphorus analyses of the samples, as well as their specific rotations in 10% hydrochloric acid, were in good agreement with the reported values for yeast adenylic acid. Furthermore, the specific rotation in 10% hydrochloric acid did not vary appreciably from one lot of acid to another. In an attempt to correlate this variation in yield of brucine adenylate with the purity of the various samples, 2 other tests were carried out on several commercial samples of yeast adenylic acid as well as on 3 samples of purified acid. One of these was a measurement of the decomposition temperature, while the other was a determination of the specific rotation in anhydrous formamide solution. Since the rate of solution of yeast adenylic acid in formamide of low conductivity is slow, further measurements of the specific rotation were made in anhydrous formamide containing small amounts of N-methylmorpholine. The results indicate that the specific rotation of yeast adenylic acid in anhydrous formamide is a more sensitive criterion of purity for this substance than the decomposition temperature, percentage of nitrogen and phosphorus, or the specific rotation in 10% hydrochloric acid. 11 references.

2119 Lithium hydride. Kermit Anderson. Fairchild Engine and Airplane Corporation NEPA-547, May 25, 1948. 39p.

Lithium hydride is quite similar to the other alkali hydrides in many respects. It is a grayish-blue to white crystalline solid, it is a strong reducing agent, reducing CO_2 to carbon and alcohol to hydrogen and an alcoholate. It reacts rapidly but not violently with cold water according to the equation $LiH + H_2O \rightarrow LiOH + H_2$. It will react with chlorine if heated. It will not react with dry air or oxygen at room temperature, but kindles on very slight heating. It should not be ground with a pestle and mortar unless done under argon or hydrogen since the frictional heat of such grinding is sufficient to set it on fire. The material is relatively stable toward thermal decomposition when protected from oxidants during heating. There is very slow decomposition even as high as 800°C with pressures as low as 10 mm maintained by a vacuum pump. This may be attributed to the retardation of decomposition by initiation of the reverse reaction in the presence of free lithium. The compounds LiH is 12.6% hydrogen by weight. The melting point is usually given as 680°C although data exist which indicate that the melting point may be nearer to 700°C. It is crystallized in the face-centered cubic form, behaving, in this respect, as an alkali halide. First Moers (Z. anorg. algem. Chem. 113, 178 (1920)) and later Kurt Peters (Z. anorg. algem. Chem. 131, 140 (1923)) proved that hydrogen migrated to the anode on electrolysis of the fused salt. Peters showed that the material followed Faraday's law. Since the compound exhibits a definite melting point, has a salt-type crystalline form, and quantitatively obeys Faraday's law, it is an excellent example of a saline type hydride. 42 references.

CHEMISTRY (continued)

2120 Tabulated data on hydrogenous materials. J. W. Johnson, A. L. Grunewald, and W. D. Powers. Fairchild Engine and Airplane Corporation NEPA-629, June 10, 1948. 25p.

The report is based on an examination of materials from the standpoint of high hydrogen content and temperature stability. A selected group of materials is presented in four sections as follows: (1) those which can be heated up to the temperature indicated in air without decomposition, (2) solids which can be heated to the temperatures indicated if they are covered to keep from being oxidized by atmospheric oxygen or reaction with moisture, (3) liquids which can be heated in air to the temperatures indicated with vapor pressures not to exceed one mm of mercury and where no reaction with water or oxygen occur, and (4) liquids which require covering due to reaction with water or oxygen or with vapor pressures higher than one mm. A section on hydroxides, a graphical comparison of the compounds listed in the first five sections with the envelope curve of titanium and zirconium hydrides, and a summary list of all the compounds investigated are included.

2121 Design of radioactivity laboratories. W. H. Ray. AECU-565(M-4401), Nov. 10, 1947. 5p.

Some basic principles to guide the design of the facilities and the performance of the work to be carried on are stated. Contamination of surfaces and air, shielding against β and γ radiation, handling of radioactive sources, radioactive waste disposal, and instrumentation for radiation control and monitoring are all considered briefly.

2122 The design of radiochemical laboratories. W. H. Ray. AECU-566(M-4402), nd. 10p.

Safety in a radiochemical laboratory requires that each individual permitted to control any radioactive material shall be competent and responsible to prevent exposure to any person of radiation dosage in excess of the maximum permissible rate (0.1 rem/day). This responsibility extends beyond the radiation produced by sources assigned to the responsible person, and in some cases may mean that no additional exposure to radiation from these sources can be permitted. Control over all radioactive material is to be maintained until it is transferred to other competent and responsible individuals or until an approved preparation for disposal has been compounded. Contamination by radioactive materials must be controlled to keep radiation sources from entering the body by inhalation, ingestion, or injection. Contamination also requires control to eliminate interference with instrumentation and the fouling of experiments. Penetrating radiation dosage can be controlled by shielding, remoteness from source, and limitation of time of exposure. Remote control is a necessary consequence in most instances. Instrumentation is advised to guide operations and establish success or failure of radiation protection measures. A list of malpractices to be guarded against in a radiochemical laboratory is included.

2123 Determination of particle size distribution. Evan C. Evans, III. Naval Radiological Defense Laboratory report NR-ECE-1, Mar. 2, 1949. 15p.

Six commonly-used methods for determining particle-size distribution in a polydisperse system are discussed. Five methods are covered rather briefly: pipet method, hydrometer method, Cummings sedimentation method, Oden balance method, and Svedburg and Rinde optical method. A pressure change method, which measures the size distribution by noting the pressure variation with time at a fixed distance below the surface of a particle suspension, is described in detail. This method combines simplicity of apparatus with good accuracy and a minimum of manipulation. The apparatus selected is a modification of Ostwald and Von Hahn's sedimentation tube designed by Kelly (Ind. Eng. Chem. 16, 928(1924)).

CHEMISTRY (continued)

2124 A small high temperature vacuum furnace. K. B. Alberman. Atomic Energy Research Establishment report AERE C/R-316, Feb. 1949. 14p.

A small and convenient vacuum furnace is described, suitable for heating gram quantities of materials to temperatures up to 2200°C at pressures down to 10^{-5} mm of Hg. The energy input at 2200°C is 800 - 900 watts. The furnace consists, in essence, of a helix of tungsten wire, the heating element, which surrounds the crucible and which is attached at either end to a tungsten lead by means of a small loop of tantalum foil into which the end of the filament is a push fit. Surrounding the filament and concentric with it are 3 cylindrical radiation shields, the inner 2 being of molybdenum or tantalum and the outer of nickel. These cylinders are closed, at either end, with metal discs which are punched to allow the passage of the filament leads through the bottom, and to enable an optical pyrometer to be sighted on the crucible from the top. The holes in the top of the shield assembly are normally covered by means of a movable lid consisting of 3 molybdenum discs attached to a tungsten wire. In the complete assembly, the filament and surrounding shields rest in the center of a 2-liter bulb which carries a connection to the vacuum system, a connection to a vacuum gauge, and a sight tube fitted with a detachable window for use with the pyrometer. Flanges were used in preference to a ground joint to connect the 2 parts of the furnace. The limiting factors in the construction and use of the furnace are the creep rate of tungsten at high temperatures and the problem of refractories. Detailed photographs, drawings, and performance data are included.

2125 Stopcock lubricants. J. R. Farnand and I. E. Puddington. Can. J. Research 27 F, 318-22 (1949) Sept.

The addition of appropriate quantities of finely divided solids to hydrocarbon, silicone, and glycerol base lubricants has been found to greatly increase their life in stopcocks. The flow properties of the dispersions show that those solids that materially increase the high shear viscosity, without contributing greatly to the thixotropy of the system, are the most effective. This effect is produced by solids that have a polarity similar to that of liquid vehicle and are readily wetted by the vehicle. Under these conditions, a linear relation exists between the viscosity of the lubricants at a mean rate of shear of 1000 sec^{-1} and their life in the stopcock.

2126 Microchemical methods used in nuclear chemical research. B. B. Cunningham. AECD-2703, Aug. 30, 1949. Decl. Sept. 13, 1949. 84p. Proposed for publication in Nucleonics.

Microchemical methods developed primarily for use in nuclear chemical research are described and discussed. Techniques described include microweighings, microvolumetric and gravimetric analysis, solubility measurements, methods for the study of reactions between solids and gases, the preparation of small samples of various reactive metals, density measurements, microcalorimetry, microspectrophotometry, magnetic susceptibility measurements, and vapor pressure measurements. Semimicro methods developed for use in the investigation of nuclear reactions are discussed. 46 references.

2127 Comparative value and accuracy of measurements of urinary I^{131} by beta and by gamma ray counting. A. Stone Freedberg, Robert Buka, and M. J. McManus. J. Clin. Endocrinol. 9, 841-51(1949) Sept.

The results of an investigation of the phenomenon of reduced I^{131} counts in the presence of urine are presented and two methods for the measurement of activity in the urine are described. The first type of measurement involves the counting of the β rays after a correction of pH to 8.0, a dilution of the sample and an addition of minute amounts of NaI and gelatin so as to keep the total solids to less than 10 mg per sample. The procedure corrects the effects of variable pH, a coincidence error encountered with highly active solutions and the effect of urinary solids and other chemical constituents. The second technique, the measurement of urinary I^{131} activity by counting γ rays, is also described in detail; the effects of coincidence error and volume on the accuracy of the determinations are discussed. Comparable results were obtained by the two methods; the β method was found to be more sensitive, but the γ method was found to be advantageous in cases of I^{131} concentration of 0.25 μc or more per cc because of its simple procedure and the rapidity of activity determination. The γ method, therefore, is recommended for most urinary determinations involving activities of 1 μc or more per 24-hr period. 13 references.

CHEMISTRY (continued)

2128 The determination of manganese in uranium manganese alloys. M. Gibson. Atomic Energy Research Establishment Report No. AERE-C/R-350, Feb. 1949. 17p.

Two methods have been developed for the determination of manganese in uranium-manganese alloys. In each case experimental work leading up to the establishment of the method is given. In one method, manganese is determined volumetrically after solution of the alloy in nitric acid and oxidation with sodium bismuthate to permanganate. The permanganate is titrated with standard ferrous ammonium sulphate. This method is suitable for the determination of manganese contents varying from 1% to >90% with an error not exceeding ±0.25%. In the other method, manganese is determined colorimetrically as permanganate. The alloy is dissolved in nitric acid, phosphoric acid is added, and the oxidation carried out with potassium periodate. The method is rapid and suitable for manganese contents from 0.2 to 10% with an error not exceeding ±2%. The final detailed procedure for each method is given.

2129 The measurement of radioactive sulphur (S^{35}) in biological material. L. Young, M. Edson, and J. A. McCarter. Biochem. J. 44, 179-85(1949).

A method for the measurement of radioactive sulphur (S^{35}) in biological material is described. A sample of the material was oxidized by the Carius method and the sulfate was precipitated as benzidine sulfate; the radioactivity of the benzidine sulfate was measured in an ionization chamber operated in conjunction with an FP-54 valve amplifying system and a galvanometer, and was compared with the activities of samples of benzidine sulfate prepared from the parent radioactive specimen. When mustard gas prepared from radioactive sulfur was analyzed in the presence of biological material (skin, leg muscle, liver, blood, feces, or urine) by this method, the mean recovery of S^{35} was 99%, and the standard deviation of a single measurement from the mean was 2.8%.

2130 Spectrochemical analysis. Technique for determining composition from alloy solutions. G. S. Smith. Metal Ind. (London) 75, 267-8(1949) Sept. 30.

A method is described which employs a "fulgurator" enabling the composition of alloy solutions to be determined directly at a rate of 30 analyses/hr. The "fulgurator" is an apparatus consisting of a glass cup which holds about 3 ml of the solution to be analyzed. Within it is supported centrally a graphite cylinder which serves as the lower electrode. The graphite cylinder is kept in position by means of a platinum wire spring in the form of a fork. The "fulgurator" is held by a brass rod fixed in the glass tube. The platinum wire which supports the graphite cylinder is fused through the bottom of the cup and makes contact with the brass rod. A diagram and complete description on the use of the apparatus is included.

2131 A two-liquid phase distribution method for the separation of metallic elements. M. Calvin. AECD-2710, Aug. 1, 1949. Decl. Sept. 23, 1949. 7p. Proposed for publication in J. Am. Chem. Soc.

The general principles of a liquid-liquid solvent extraction method for the separation of metallic elements are outlined. The method depends upon the formation of unionized chelate compounds by the elements with certain organic reagents and the small solubility of these compounds in water compared to their solubility in water-immiscible organic solvents. It is shown that it is possible to select a chelating agent having a fairly high acid dissociation constant so as to produce fairly high concentrations of the chelating ion in the water phase, without losing the intrinsic ability of the agent to form a chelate compound.

2132 The anion-exchange separation of zirconium and hafnium. E. H. Huffman and R. C. Lilly. AECD-2714, Aug. 3, 1949. Decl. Oct. 3, 1949. 8p. Proposed for publication in J. Am. Chem. Soc.

A successful anion-exchange separation of zirconium and hafnium is reported. Elution of their fluo-salts from Amberlite IRA-400 with hydrochloric acid containing a small amount of hydrofluoric acid has been carried out. The scheme used was to adsorb zirconium and hafnium in the form of fluo-ions from a solution in hydrofluoric acid and elute them with dilute hydrochloric acid containing very

CHEMISTRY (continued)

dilute hydrofluoric acid. In the absence of hydrofluoric acid, colloid formation takes place in hydrochloric acid of the concentration used, with subsequent sticking of the colloid particles to the resin.

2133 Carrier-free radioisotopes from cyclotron targets. V. Preparation and isolation of Se^{75} from arsenic. Warren M. Garrison, Roy D. Maxwell, and Joseph G. Hamilton. AECU-579(UCRL-450), Aug. 1949. 4p.

Deuteron bombardment of arsenic produces 127-day Se^{75} by the nuclear reaction, As^{75} (d,2n)Se^{75} (C. V. Kent et al, Phys. Rev. 61, 389(1942)). This paper reports a radio-chemical isolation of carrier-free Se^{75} from an arsenic target bombarded with 19-Mev deuterons in the 60-in. cyclotron at the Crocker Laboratory. The possible (G. T. Seaborg and I. Perlman, Rev. Mod. Phys. 20, 585(1948)) radioisotopes of germanium (from n,p reaction) and gallium (from n,α reaction) were allowed to decay out prior to the separation.

A 2-mm layer of C.P. arsenic powder, supported on a grooved water cooled copper plate by a 0.25-mil tantalum foil, was bombarded for 100 μa-hr at a beam intensity of 8 μa. After aging for 24 hr, the bombarded arsenic was dissolved in a minimum volume of aqua regia. 12 N HCl was added to destroy excess HNO_3 and the solution was adjusted to 3 N. 10 mg of tellurous acid were added and precipitated as elemental tellurium with SO_2; approximately 95% of the Se^{75} carried. The supernatant showed the 26.8 hr period of As^{76}. The tellurium precipitate containing the carrier free radio-selenium was dissolved in 16 N HNO_3 and reprecipitated from 3 N HCl in the presence of arsenic hold-back carrier. Two additional precipitations removed traces of carrier arsenic.

The tellurium precipitate was washed, dissolved in a minimum volume of 16 N HNO_3, and transferred to an all-glass distilling flask (J. A. Scherrer, J. Research Natl. Bur. Standards, 21, 95(1938)). 14% HBr was added dropwise while a stream of N_2 carrier-gas was bubbled through the solution at 200°C. Under these conditions, selenium forms the volatile tetrabromide while tellurium is quantitatively retained in the residue. The distillate, containing the carrier-free Se^{75}, HBr, and Br_2 was collected in a water trap cooled with ice. HBr was removed with HNO_3 and the solution was evaporated to dryness on 40 mg of NaCl after the addition of excess HCl. The activity, presumably as selenate, was quantitatively soluble in 5 ml of water. The resultant isotonic solution of carrier-free radio selenium was used in subsequent biological experiments.

The Se^{75} was identified by the assigned (H. H. Hopkins, Jr. and B. B. Cunningham, Phys. Rev. 73, 1406(1948)) 120-day half-life and by the 0.45-Mev gamma ray (W. S. Cowart et al, Phys. Rev. 73, 1454 (1948)). Chemical separations with added arsenic and selenium carriers further identified the activity as Se^{75}.

2134 Ionization of paraffin wax by beta-radiation. Andrew Gemant. J. Applied Phys. 20, 887-91 (1949) Oct.

This is a quantitative experimental study of the primary ionization of paraffin wax by β radiation. Electrons emitted by uranium and carbon-14 were used. Interpretation, by means of a simple theory, of experimental data on the electrical conductivity permits evaluation of the ionic mobility in paraffin and the efficiency of ion-pair production. Only small primary ions of relatively long mean life are detected by the conductivity method. Dipolar admixtures promote secondary reactions and lower the level of conductivities attained. No ionization was detected in two hydrocarbon polymers.

2135 Polymerization with the aid of γ rays. Adolphe Chapiro. Compt. rend. 228, 1490-2(1949) May (in French).

Polymerization of styrene with the aid of γ rays was studied using a Ra source surrounded by 1 mm Pb, the intensity of the source varying from 100 - 400 mc. The reaction took place at 12 ± 1°C. in small flasks placed 4.5 cm from the source. The reaction is slow: 1.5×10^{-2} g % of polystyrene formed per curie hr. The amount of the conversion is a linear function of time, and is proportional to the square root of the source intensity. Dainton (J. Phys. and Colloid Chem. 52, 490(1948)) has recognized the important part played by free OH groups in a similar polymerization of acrylonitrile in aqueous solution.

CHEMISTRY (continued)

The present author observed the same effect in the case of styrene; since the latter is insoluble in water, he used different alcohols (from methanol to n-hexanol); the velocity of the reaction increased up to 2.8 times, and the independence of the effect from the nature of the alcohol showed that the effect was due to the influence of the hydroxyl group. The following substances produce, in various degrees, a similar acceleration of the polymerization of styrene under the action of γ rays: amines, (they cause a retardation of the thermal polymerization), acetone, propionitrile, hydrocarbons.

2136 C^{14} uniformly labeled starch and glucose. Martin Gibbs, Rosemary Dumrose, and Frances Acher. AECU-557, nd. 7p.

Starch labeled with C^{14} has been prepared by exposing carbohydrate-depleted bean leaves to an atmosphere of $C^{14}O_2$ in the presence of light. The starch was extracted from the leaves by means of dilute perchloric acid, then precipitated with iodine and reconverted to starch. After decomposing the starch-iodine complex with alcoholic sodium hydroxide, the liberated starch was reprecipitated with 95% alcohol, filtered, and washed with alcohol. The pure starch was then hydrolyzed to glucose with dilute sulfuric acid.

2137 Conversion of 1,2-aminoalcohols to carbonyl compounds. Richard T. Arnold. AECU-575 (UCRL-451), Sept. 15, 1949. 14p.

Cyclohexanone has been synthesized in yields of 20-25% from cyclopentanone by the following procedure: cyclopentanone is converted to its cyanhydrin with hydrocyanic acid, the cyanhydrin hydrogenated to an amino alcohol, and the latter treated with nitrous acid to give cyclohexanone. Cycloheptanone has been prepared from cyclohexanone in yields of 45% by the same general procedure. By use of C^{14} as a tracer in the cyanide, it has been established that all of the carbon from the cyanide occupies the 2-position in the cyclohexanone. No isotope exchange effect was observed. 10 references.

2138 Synthesis of 5-octynoic and cis-5-octenoic acids. David R. Howton and Robert H. Davis. AECU-580(UCLA-41), Sept. 22, 1949. 15p.

Starting with trimethylene iodochloride and 1-butyne, cis-5-octenoic acid has been prepared via the intermediates 4-n-heptynyl chloride and 5-octynoic acid. Trimethylene iodochloride, prepared by the action of an acetone solution of sodium iodide on trimethylene chloride (Hass and Huffman, J. Am. Chem. Soc. 63, 1234(1941)), was condensed in liquid ammonia solution with sodium butynide to give 4-n-heptynyl chloride (I). The chloro group of this intermediate was then replaced by cyano, using sodium cyanide, and the resulting nitrile (which was not isolated) hydrolyzed directly to $CH_3CH_2C{\equiv}CCH_2CH_2CH_2COOH$ (II). The overall yield of II from trimethylene iodochloride was 30%. That II has the expected structure was shown by catalytic hydrogenation, in which process two molecular equivalents of hydrogen were absorbed and caprylic acid formed; and by permanganate oxidation, yielding fragments in agreement with the Δ^5-location of the triple bond. During the hydrogenation of II over W-5 Raney nickel (Adkins and Billica, J. Am. Chem. Soc. 70, 695 (1948)) at atmospheric pressure and room temperature, a sharp decrease in the rate of hydrogen-up-take occurs when one molecular equivalent of the gas has been absorbed; hence it is possible to prepare cis-5-octenoic acid (III) essentially free of both II and caprylic acid. Observations made during the preparation of solid derivatives of III show that the acid has a high stereoisometic purity - i.e. that the controlled hydrogenation is highly stereospecific and the product hence essentially free of trans-5-octenoic acid. 12 references.

CHEMISTRY (continued)

2139 Preparation of radioactive hydrogen sulphide. U. Croatto and A. G. Maddock. Nature 164, 613-14(1949) Oct. 8 (Letter to the editor).

If rubidium instead of potassium chloride is irradiated in an atomic pile in the preparation of S^{35}, it has been found that about 50% of the active sulfur can be separated as hydrogen sulfide by treatment of the irradiated salt with aqueous hydrochloric acid containing a trace of hydrogen sulfide as carrier. Separation from active rubidium can easily exceed 99.99% efficiency. The rubidium salt need not be specially treated, nor need the irradiation be conducted in vacuo. Thus the S^{35} formed by the (n,p) reaction in Cl^{35} behaves similarly to that produced by the (d,α) reaction in Cl^{37} in the same medium (Kamen, Phys. Rev. 60, 537(1941)).

2140 Preparation of sucrose labeled with C^{14} in the glucose or fructose component. H. Wolochow, E. W. Putman, M. Doudoroff, W. Z. Hassid, and H. A. Barker. J. Biol. Chem. 180, 1237-42(1949) Oct.

Sucrose with a C^{14}-labeled fructose component was synthesized with the aid of C^{14}-fructose, inactive sucrose, and an enzymatic extract from Pseudomonas saccharophilia; sucrose with a C^{14}-labeled glucose component was prepared by allowing labeled glucose-1-phosphate to react with inactive fructose in the presence of the same enzyme. It was shown that practically all of the disaccharide was accounted for by the fructose portion in the first synthesized preparation, while most of the activity was accounted for by the glucose portion in the second preparation.

2141 Some aspects of isotopic exchange reactions. Elizabeth Rona. AECU-540(UAC-129), July 19, 1949. 5p.

Some aspects of the application of radioactive isotopes to the study of isotopic exchange reactions, are discussed. Exchange reactions can only be studied if reversible equilibrium exists and if no isotopic differentiation occurs. A general system may be written in the following way: $A + B^* \rightleftharpoons A^* + B$ where the ion with asterisk is labeled with the radioactive isotope. Exchange may take place between species of the same oxidation states or between different oxidation states, it always involves the transfer of one or more electrons. Electron transfer reactions were considered until lately to be very fast. Rapid exchange has been reported for Pb(II) and Pb(IV), Hg(I) and Hg(II), manganate and manganous ions. On the other hand, it was found recently that the exchange between Tl(I) and Tl(III) also between Fe(II) and Fe(III) was slow. Electronic exchange is rapid between the ferrocyanide and ferricyanide ions (R. C. Thompson, J. Am. Chem. Soc. 70, 1045(1948)), but here important structural features are involved as was pointed out by Pauling (Echanges Isotopiques et Structure Moleculaire Colloques. intern. Paris, (1948)); the resonance of single bonds-double bonds, between the central atoms and the coordination groups of the cyanide complexes, which may be a possible mechanism for the transfer of an electron from the center of the atom. On the other hand, no exchange was observed between ferric ion and ferrocyanide, ferrous ion and ferricyanide, and ferric ion and ferricyanide ions. Structural factors predominate over bond types in the exchange reactions of α, α'-dipyridyle complex, in which the iron-nitrogen-bonds are mainly covalent and which, undergoes rapid exchange; whereas ferriprotoporphyrin, where the iron is held by electrostatic forces, does not exchange (S. Reuben et al, J. Am. Chem. Soc. 64, 2297(1942)). In this compound the central metallic ion is surrounded by a "fused" ring and 4 metal-nitrogen bonds have to be broken simultaneously. 16 references.

2142 Thorium-carbon system. H. A. Wilhelm and P. Chiotti. AECD-2718, nd. Decl. Sept. 30, 1949. 22p.

A study of the thorium-carbon system has been made and a tentative constitutional diagram constructed from metallographic, x-ray, and melting point data. Thorium forms two carbides; ThC (4.92% carbon) and ThC_2 (9.38% carbon). The monocarbide has a sodium chloride type structure with a_o = 5.325 A and the dicarbide has a pseudo tetragonal lattice. The monocarbide melts at 2625 ± 25°C (4755°F) and the dicarbide at 2655 ± 25°C (4855°F). Thorium dissolves up to approximately 0.75% carbon at 1975°C (3585°F) and holds less than 0.25% carbon in solid solution at room temperature. The monocarbide will dissolve up to 85% thorium at 1975°C and holds approximately 23% thorium in solid solution

CHEMISTRY (continued)

at room temperature. At elevated temperatures the monocarbide and dicarbide apparently form a complete series of solid solutions while at room temperature they show no mutual solid solubility. The dicarbide forms a eutectic with graphite containing approximately 12.6% carbon and melts at 2500 ± 35°C (4530°F).

2143 The crystal structure of Mo_3Si. D. H. Templeton and Carol H. Dauben. AECU-573 (UCRL-425), Aug. 24, 1949. 9p.

The crystal structure of Mo_3Si has been determined from powder x-ray diffraction patterns. The lattice is cubic with a = 4.890 ± 0.002. The structure is that of β-tungsten, and the compound is isomorphous with Cr_3Si and V_3Si.

2144 Distribution of thorium isotopes between the crystals of lanthanum fluoride and its saturated solutions in 3% and 12% HNO_3 at 100°C. V. G. Khlopin and M. S. Merkulova. Doklady Akad. Nauk S.S.S.R. 65, 861-4(1949) Apr. 21 (in Russian).

According to the author's theory, the system ThF_4 - LaF_3 is similar to YF_3 - CaF_2 in that systems of these types form abnormal mixed crystals, i.e., there exists for them a lower limit of miscibility. The thorium isotope used was UX_1 (Th^{234}), and, since its concentration in the solutions is exceedingly low, no mixed crystals with LaF_3 should form. However, the experiments described here showed that the distribution of UX_1 between the crystals of LaF_3 and the saturated solution of LaF_3 in HNO_3 followed the Henry-Dalton-Nernst law and thus proved the existence of normal mixed crystals. This contradiction with the authors' theory was resolved after it was found that the lanthanum salts used in the experiments contained Th; the Th content of the solutions was thereby considerably increased, and the concentrations were certainly above the probable lower limit of miscibility.

2145 Domain structure and dielectric response of barium titanate single crystals. B. Matthias and A. Von Hippel. MIT Technical Report No. 9, Feb. 1948. 24p. (NP-929).

Single crystals in $BaTiO_3$ have been grown and investigated by means of the polarization microscope, x-ray diffraction, and their dielectric and piezo-electric response. It has become possible to see the domains in the ferroelectric state and to change their number, size, and orientation. Wall displacements and the alignment of such domains, for which indirect evidence exists in the case of ferromagnetics, have been observed in both polarized and unpolarized light; and the influence of temperature and electric fields on the domain structure and orientation of the polar axis have been investigated. In addition to the Curie point near 120°C, there exist two polymorphic transitions near 5°C and -70°C. A tentative explanation for the development of the ferroelectric state is given which brings the new ferroelectric group of the titanates into close relation to those of the tartrates and phosphates. 14 references.

2146 Structure of diborides of titanium, zirconium, columbium, tantalum, and vanadium. John T. Norton, H. Blumenthal, and S. J. Sindeband. J. Metals 1, 749-51(1949) Oct.

The borides of Ti, Zr, V, Cb, and Ta corresponding to the formula MeB_2 have isomorphous crystal structures with the metal atoms arranged in a simple hexagonal lattice having an axial ratio slightly greater than unity. The structure is of the C 32 type, space group D^1_{6h} - C6 mmm, with metal atoms at 0, 0, 0 and boron atoms at 1/3, 2/3, 1/2 and 2/3, 1/3, 1/2. The unit cell contains one molecule of MeB_2. This structure corresponds to alternate layers of metal and boron atoms, parallel to the basal plane of the lattice. As the metal atom size increases, both α and c dimensions of the lattice increase and the axial ratio also increases slightly. The borides have well developed metallic properties.

CHEMISTRY (continued)

2147 X-ray powder diffraction analysis film and Geiger counter techniques. William Parrish. Science 110, 368-71(1949) Oct. 7.

The Geiger-counter x-ray spectrometer is discussed in some detail and other of the techniques and instruments for x-ray powder diffraction are reviewed. In the former a Geiger tube is used, in place of the customary film, as a detector. 12 references.

2148 The relation of apparent to true pH in deuterium solutions. R. G. Hart. National Research Council of Canada Report CRE-423, June 1949. 15p.

The standardization of acidity scales for heavy water solutions using both colorimetric and electrochemical measuring devices is reported. Colorimetric pH readings and readings on the Beckman Model G pH meter are given for known deuterium ion activities in deuterochloric acid solutions and in disodium deuterium phosphate-potassium dideuterium phosphate buffered solutions. Electrochemically measured results must have 0.4 pH units added, and colorimetric results must have 0.7 to 0.8 pH units added to obtain true pD values as defined by $-\log a_D{}^+$. The methods of preparation of the heavy chemicals used are described. Light acid and light buffer solutions were used as a control throughout the investigation.

2149 Reactions of polyfluoro olefins: I. Preparation of sulfides and sulfones. Karl E. Rapp, Roy L. Pruett, John T. Barr, Carl T. Bahner, J. Donald Gibson, and Robert H. Lafferty, Jr. AECU-577(K-501), Sept. 23, 1949. 15p.

Thiols in the presence of an alkaline catalyst reacted readily at or near room temperature with polyfluoro olefins such as chlorotrifluoro-ethylene, 1,1-dichloro-2,2-difluoroethylene, and hexafluorocyclobutene to produce polyfluoroalkyl sulfides. The sulfides prepared are relatively stable toward most reagents and have unusual physical and chemical properties. Benzyltrimethylammonium hydroxide or sodium ethyl sulfide catalyst produced a 95% yield of ethylthiochlorotrifluoroethane from ethanethiol and chlorotrifluoroethylene, while tributylamine catalyst produced a lower yield because of slower reaction. Mercaptoacetic acid and 2-mercaptoethanol reacted as did simple alkane thiols. Sulfones were prepared by oxidation of polyfluoroalkyl sulfides with $KMnO_4$ in aqueous acetic acid. Chemical and physical properties of the sulfones prepared are discussed. Reactions of hexafluorocyclobutene with thiols were complicated by the elimination of HF to produce unsaturated sulfides which were capable of further reaction. 1-Butylthio-2,3,3,4,4-pentafluorocyclobutene, 1,2-bis(butylthio)-1,3,3,4,4-pentafluorocyclobutane, and 1,2-bis(butylthio)-3,3,4,4-tetrafluorocyclobutene were obtained from hexafluorocyclobutene and 1-butanethiol. 9 references.

2150 The magnetic susceptibility of bromine-graphite. M. Goldsmith. AECU-545(UAC-140), nd. 8p.

If graphite is exposed to an atmosphere containing bromine vapor, bromine is intercalated (W. Rudorff, Z. anorg. u. allg. Chem. 245, 383 (1941)) between the layer planes of the graphite lattice; the substance thus formed is known as "bromine-graphite." The magnetic susceptibilities of graphite and bromine-graphite have been measured. Possible structures of bromine-graphite are discussed. The data obtained together with those of Rudorff (International Critical Tables, Vol. 6, p. 354) indicate the possible presence of both molecular bromine and a small number of carbon-bromine bonds in bromine-graphite. 11 references.

CHEMISTRY (continued)

2151 Absorption spectrum and radiation fields of Ho^{+3} ions in solid salts, (with a supplement on the spectrum of the solid Er sulfate). Hans Severin. Z. Physik 125, 455-74(1949) (in German).

New measurements of the absorption spectrum of $Ho_2(SO_4)_3.8H_2O$ are described. The optically uniaxial $Ho(C_2H_5SO_4)_3$ was used for the determination of the radiational characteristics of the lines; it was found that all the lines absorb the electric dipole radiation. The coupling between the 4f electrons and the crystal lattice is smaller in the case of Ho than in that of Er.

2152 Influence of adsorption on the absorption spectra of neodymium. H. Volkringer and Valladas-Dubois. J. chim. phys. 46, 388-95(1949) July-Aug. (in French).

Since it has already been observed that adsorption modifies the position and often the intensity of the absorption bands of many substances, the authors reconsidered this question using as the adsorbed substance a salt of neodymium. They studied, in the visible, the absorption spectrum of neodymium adsorbed by aluminum and magnesium oxides. The salts of neodymium used were the sulfate, the chloride, and the nitrate. The spectra obtained were compared with those given by the salts in the crystalline state and in aqueous solutions, and by neodymium oxide. The spectra obtained in the study of the three salts were identical in all three cases. They were independent of the anion and corresponded closely to the spectrum of the adsorbed Nd^{+3} ion. The spectrum of the adsorbed ion differed from those of the different salts taken either in the crystalline state, or in solution, but it was similar to the spectrum of the hydroxide with slight displacements of about 20 A. 21 references, 11 figures.

2153 On the isotopic shift in the samarium spectrum. Peter Brix and Hans Kopfermann. Z. Physik 126, 344-64(1949)(in German).

The hyperfine structure of several samarium lines, between 4,300 and 7,200 A, obtained with a Fabry-Pérot interferometer, was photographed and investigated, chiefly with the view to determine the isotopic shift of the even isotopes. The only finding concerning the odd isotopes was that the spin of Sm 147 and Sm 149 is $\geq 3/2$. A very careful photometric study of five SmI lines resulted in the determination of the relative localization of Sm 150 and Sm 152, and of the value of the corresponding anomalous isotopic shift. It was found that the relative shifts of Sm agree with those of the neighboring Nd, when isotopes with equal neutron numbers are compared. In the spectra of SmI and SmII, it was possible to correlate the isotopic shifts with the corresponding spectral terms, and to calculate, for a given isotope pair, "constants of isotopic shifts" that are independent from the electronic envelopes of the atoms. These constants are compared with those of other heavy elements, insofar as they can be derived from the known data, and the results are discussed in the light of the theory of the isotopic shift effect. The anomalous shift of Sm, which can be tied-in with the discontinuity of the quadrupole moments of Eu, is explained with the aid of a simplified nucleus model.

CHEMISTRY (continued)

2154 Exploratory studies on the removal of plutonium from liquid wastes by activated sludge. John F. Newell. AECD-2712, nd. Decl. Oct. 4, 1949. 8p.

Characteristics of wastes from the nuclear energy industry and the selection of an exploratory study program are considered. The discussion in this paper is limited to the activated sludge process. An ultimate goal of one thousandth of a μg (one-billionth of a g)/l was tentatively selected as the maximum desirable concentration of Pu^{239} in waste solutions after treatment. This quantity is about one-tenth of the tolerance which has been tentatively established for the plutonium in drinking water. One μg/l is one part per billion and for the material under consideration is equivalent to about 70,000 counts/min/l. One thousandth of a μg/l is one part per trillion and is registered on the counting equipment as about 70 counts/min/l. Exploratory work indicated that the biological adsorptive material present in activated sludge will remove from 90-95% of tracer quantities of Pu^{239} from aqueous waste solutions. The radioactive material was removed from the solution and concentrated into the sludge. The level of radioactivity was built up to high levels in the sludge without affecting the biological process. Because of the high radioactivity of the waste sludge special safety precautions were used in its handling and disposition. Because of the high concentration of radioactivity in the sludge, unfiltered samples showed as high as 28% carry-over of radioactivity by suspended matter in the effluent. This suggests final treatment of effluent by filtration to assure the effectiveness of the process.

2155 Isolation and properties of curium. Louis B. Werner. AECD-2729, July 28, 1948. Decl. Oct. 18, 1949. 90p.

The isolation of curium, element number 96, in relatively pure form is reported. A method involving a solvent extraction process, is given for the purification of americium from lanthanum and other ions. The discovery of a higher oxidation state of americium led to a method of separating americium from curium. Separation of the two elements was also accomplished by use of the ion exchange resins. The details of the isolation of curium are given; the results of the spectrographic analysis, specific activity measurement, and calorimetric determination of half-life showed the curium to be relatively pure. The absorption of light of various wavelengths by an aqueous solution of Cm(III) is described, and some physical effects of the radiation from the curium are noted. 26 references.

2156 Determination of traces of uranium using the polarograph. The catalytic reduction of nitrate ions in the presence of uranyl ions. Charles E. Crompton, R. L. Tichemar, and H. A. Young. AECD-2704, Apr. 10, 1945. Decl. Sept. 20, 1949. 16p.

The catalysis by uranium of the reduction of nitrate ion at the dropping mercury electrode has been found to provide a method of analysis for small amounts of uranium (0.008 to 1.1 ppm.) only when nearly all other ions are absent. The optimum supporting electrolyte is: 0.05 M NO_3^-, 0.03 M H^+, 0.005 M Cl^-, 1.035 M Na^+, and 0.0001 to 0.0002% methyl red. Anions interfere, roughly, in proportion to their ability to form complexes with uranyl ion. Among the cations which are not reduced before H^+ is discharged at the mercury cathode, the polyvalent ions cause the largest decrease in the catalytic current.

2157 Report on studies concerned with organic compounds of uranium. Henry Gilman and R. G. Jones. AECD-2713, nd. Decl. Sept. 30, 1949. 36p.

This report on volatile uranium compounds covers work done from February, 1942, to March, 1943. Preparation of a wide variety of uranium compounds and tests for volatility are reported. Although many of the compounds were entirely non-volatile, they are described here as a contribution to the general chemistry of uranium. The report is divided into four sections. The first section deals with tetravalent uranium compounds, the second with pentavalent compounds, the third with hexavalent compounds, and the fourth with the uranyl type compounds.

CHEMISTRY (continued)

2158 The crystal structures of metallic uranium. Charles W. Tucker, Jr. AECD-2716, July 21, 1949. Decl. Sept. 23, 1949. 17p. Proposed for publication in Transactions.

Uranium metal exhibits three crystalline forms before melting at 1133°C (2071°F). The α-phase is stable up to 640°C (1184°F). It crystallizes in the orthorhombic system with space group D_{2h}^{17} and a_o = 2.852 A, b_o = 5.865 A, c_o = 4.945 A. Its structure may be regarded as being formed by the stacking of corrugated sheets of atoms. The binding within the corrugated sheets appears to be largely covalent, thus forming a lyer structure analogous to that found in the structures of arsenic, antimony, and bismuth. The β-phase is stable between 640°C (1184°F) and 760°C (1400°F) and its crystal structure is not yet known. The structure is complex and appears to involve a unit cell much larger and of lower symmetry than the α-phase. The γ-phase is stable from 760°C (1400°F) up to the melting point. It crystallizes in the body-centered cubic structure with a_o = 3.474 A. Some of the physical properties of the three phases are readily understood in terms of their crystal structures.

2159 The reduction of water vapor by uranium metal. W. M. Jones. AECD-2724, nd. Decl. Oct. 14, 1949. 8p. Proposed for publication in J. Am. Chem. Soc.

A procedure is described in which small water samples of the order of a few tenths of a g can be converted quantitatively to hydrogen gas by reduction with uranium metal. The reaction is carried to completion in a quartz reaction tube at high temperatures, and the hydrogen formed is pumped through a heated palladium valve by an automatic Toepler pump for measurements. Experimental results establishing the completeness of conversion to within 0.01% are included.

2160 Further polarographic studies of the uranyl citrate complex. W. F. Newman, J. Havill, and I. Feldman. AECD-2728, July 27, 1949. Decl. Oct. 18, 1949. 13p. Proposed for publication in J. Am. Chem. Soc.

A recent publication elsewhere demonstrated that UO_2OH^+ gives a polarographic wave above pH 4.2 which would interfere markedly with polarographic studies of the uranium citrate complex. Therefore, the polarography of uranium in citrate medium has been reinvestigated. Except below pH 4.2 or with an excess of citrate, the formation of UO_2OH^+ was found to interfere polarographically. Further data have been obtained and the dissociation constant,

$$K_c = \frac{[UO_2^{++}]\,[H_2\ \text{citrate}^-]}{[H^+]^{3/2}[\text{dimerized complex}^-]^{1/2}}$$

was redetermined at a slightly lower pH (2.94-3.57) and found to be 0.18 ± .08.

2161 On the electrolytic preparation and properties of uranium borides. Jean-Lucien Andrieux and Pierre Blum. Compt. rend. 229, 210-12 (1949) July 18 (in French).

Since earlier experiments by one of the authors had shown that a uranium boride, UB_4, could be formed by the electrolysis of a bath of molten borate and alkaline earth fluorides in solution with a quantity of U_3O_8 (Andrieux, Ann. chim. 10, 423 (1929)), an attempt was made to prepare new borides of uranium by varying the concentrations of borate U_3O_8 in the bath and by substituting magnesium fluoride for the alkaline earth fluorides. In the first attempts the concentration of U_3O_8 was too great in respect to the borate and only UB_4 was formed. When the concentration of U_3O_8 was reduced to as much as 1/40 molecule to two molecules of the borate, there resulted a mixture of UB_4 with a new boride UB_{12}. The two borides can be separated by the use of concentrated hydrochloric, or sulfuric acids, since UB_4 is easily attacked by these while the UB_{12} is very resistant to the acids.

2162 On the orange-colored compound of uranium and the genetic relations between the pentauranate, the orange-colored compound and a red-compound of uranium. André Chretién and Gabriel Tridot. Compt. rend. 229, 367-9(1949) Aug. 1 (in French).

CHEMISTRY (continued)

The process which leads to the formation of the pentauranate of sodium, $5UO_3.Na_2O$, and its transformation into a pentauranate-bisulfide of sodium by mutual action of sodium sulfide and uranyl nitrate is studied here. Depending on the pH of the solution, the orange-colored double salt, $5UO_3.Na_2O.2NaHS$, transforms either into the original pentauranate or into a red-colored triple salt, $5UO_3.Na_2O.NaHS.Na_2S$. It was thus possible to establish the genetic relations between the pentauranate and the double and triple sulfide salts, and also to determine the nature of the latter two.

2163 On the complex chemistry of the uranyl ion. I. The hydrolysis of the six-valent uranium in aqueous solutions. Sten Ahrland. Acta Chem. Scand. 3, 374-400(1949).

It has been shown by extinction measurements that the uranyl ion is the only existing complex of six-valent uranium in aqueous solution from pH ≈ 0.1 (the lowest investigated) up to pH ≈ 2. Over that pH further hydrolysis complexes are gradually formed. Thus the uranyl ion may be regarded as a complex-forming central group, and the formulas for its complex formation have been developed in a manner analogous to that for other metal ions. The further hydrolysis of uranyl ion has been studied by hydrogen ion measurements when $UO_2(ClO_4)_2$ solutions were titrated with NaOH. The total uranium concentration ranged from 2 mC to 60 mC. The ionic strength of the solutions was kept constant and equal to one with the aid of $NaClO_4$. The determinations were done, first with a quinhydrone electrode and then with a glass electrode. Both electrodes gave essentially the same image of the hydrolysis complex formation, which may be described as follows: (1) The hydrolysis becomes appreciable at pH ≈ 3. Precipitation does not occur until, on the average, 1.3 OH^- has been used per uranyl ion; pH is then 4.5-5. (2) The complex formation curves found at different C_m (total concentration of central atom) prove that a polynuclear complex formation plays a very important role in the hydrolysis, even at the smallest C_m. This fact places the uranyl ion in an analogous position to other metallic ions, containing oxygen, in the same group of the periodic system: chromate, molybdate, tungstate. The first mononuclear dissociation constant x_1' and the first dinuclear x_1'', have been determined. At 20°C they were found to be: $x_1' = (2.0 \pm 0.4) \times 10^{-5}$ C; $x_1'' = (4 \pm 1) \times 10^{-3}$ C. 24 references.

2164 The recovery of uranium from sodium estimation residues. F. Clark. Analyst 74, 411-12(1949) July. (Letter to the editor).

A method developed by the Chemical Inspection Department of the Ministry of Supply for the recovery of uranium from residues and liquors left after sodium determinations with zinc uranyl acetate is set forth in detail. The principle of the method is the precipitation of hydrated uranium peroxide which is converted into uranium trioxide by ignition. The trioxide dissolved readily in acetic acid, forming uranyl acetate, the salt required for preparing the precipitating agent for sodium. Liquid and solid residues are collected and treated separately. It is stated that uranium trioxide recovered by this method will be completely free from zinc if the washing is carried out efficiently.

2165 Sensitivity of uranium fluoride UF_4 towards water vapor. Louis Domange and Monique Wohlhuter. Compt. rend. 228, 1591-2(1949) May 16 (in French).

Using a method described in Ann. chim. 7, 226(1937), the action of water vapor on UF_4 was studied, the reaction involved being $UF_4 + 2H_2O \rightarrow 4HF + UO_2$. Water vapor was passed over UF_4 with different speeds; the resulting vapor phases were analyzed, and the compositions were extrapolated for zero velocity. The temperature range investigated was 200-500°C. It was found that heating with water vapor decomposes UF_4 rather easily, the sensitivity of U toward this reaction approaching that of Zn. From the values of the equilibrium constants for various temperatures, the reaction heat was found to be equal to about −30 kcal. Using the known values of the formation heat of UO_2, HF and H_2O, it is found that the formation heat of UF_4 is about 440 kcal; the value 443 ± 3 kcal is given in "The thermodynamic properties and equilibria at high temperatures of uranium halides, oxides, nitrides, and carbides", U. S. Atomic Energy Commission, MDDC-1543.

CHEMISTRY (continued)

2166 Study of a complex of uranium and choline. Colette Soye. Compt. rend. 228, 1228-30 (1949) Apr. 4 (in French).

The potentiometric curve obtained by neutralizing an aqueous solution of uranyl nitrate (0.0055 M) with a 0.55 M solution of choline is described. The first point of inflection i occurred at pH 4.40, and corresponded to the proportion of 1 uranyl nitrate to 1 choline; at pH 5.25 the solution began to precipitate and the precipitation seemed complete at the proportion of 1 U for 2 cholines. The substance for analysis was prepared by evaporation of either the filtrate of an equimolecular mixture of uranyl nitrate and choline in alcoholic or aqueous solutions, or aqueous solutions of mixtures of choline and uranyl nitrate in proportions such that the pH was equal to or less than 4. The crystals formed were bright yellow, non-hygroscopic, soluble in water, slightly soluble in alcohol, and insoluble in ether and benzene; they consisted of ray-like needles more closely grouped and finer than those of uranyl nitrate. The molecular weight determined by cryoscopy was found to be at least equal to 1030 with the corresponding formula $((NO_3)_2UO_2.\text{choline})^2$. The electrolysis was carried out in two separate tubes, joined by a siphon, with platinum electrodes releasing NO_2 at the anode, and a gaseous discharge at the cathode with the deposit of UO_3 and the liberation of choline; the respective proportions of uranium and choline remained the same at the anode, cathode and in the siphon at the start and at the end of the electrolysis. The reaction tended to prove that uranium and choline were displaced together under the action of an electric field; the substance isolated would be then the nitrate of a complex of uranium and choline.

2167 Trial determination of uranium in the state of the complex acetate. Ernest Kahane and Alfred Simenauer. Bull. soc. chim. France, Nos. 5-6, 531-3(1949) May-June (in French).

A study has been made of the precipitation of uranium as a double acetate of uranium and of sodium, or as a triple acetate of uranium, magnesium and sodium, by means of a reagent rich in sodium and magnesium.

ENGINEERING

2168 Heat transfer to superheated steam at high pressures. W. H. McAdams, J. N. Addoms, and W. E. Kennel. AECU-571 (ANL-4334), June 1949. 38p.

Local coefficients of heat transfer from a 12.3-in. length of 0.252-in. electrically-heated tubing to superheated steam flowing upward in a vertical annulus have been measured at L/D_e ratios from 11.4 to 80 (L is length and D_e is exterior diameter of heater tube), for pressures from 115 to 3500 psia, for steam temperatures from 430 to 1000°F, and for temperature differences from 100 to 620°F. The results are graphically correlated in terms of the local Nusselt number, the Reynolds number, the Prandtl number, and the geometrical ratio L/D_e, with the physical properties evaluated at the film temperature. 16 references.

2169 Gas leakage tests on shaft seals. Harry Apkarian. AECU-555(EAH-106), Aug. 15, 1949. 14p.

This data folder is a progress report of tests on 2 types of rotary shaft seals. The seals tested were a face type seal and one was an original design (referred to as the grease packed seal). The tests were run on a 5/8 in. shaft over a range of speeds and duty cycles, the purpose being to evaluate seals by determining the gas leakage rates while varying time, speed, and duty cycles. Of the several seals tested, the double face type seal (Syntron Co.) with water circulated through it proved to have the lowest leakage rate (less than 1 cc/yr) regardless of duty cycles, shaft speed (0-1500 rpm), or pressure differential (0-30 in. Hg). The same seal, run in a pool of oil, yielded leakage rates that varied from less than 10 cc/yr for the first hour to 100 cc/yr at the end of 1 week of continuous operation. Loss of oil and diffusion of the tracer gas, rather than seal deterioration, were responsible for the increase in the leakage rate. The grease-packed seal can be run with

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leakage rates of less than 5 cc/yr but to obtain these results, grease must be added at periodic intervals. Seals which are run dry have short life and high leakage rates.

2170 Radium, tantalum^{182}, and cobalt^{60} in industrial radiography. James W. Dutli, Gerold H. Tenney, and John E. Withrow. AECD-2719, Sept. 23, 1949. Decl. Oct. 12, 1949. 16p.

The use of Ta^{182} and Co^{60} as sources of γ radiation for the field of industrial radiography has been investigated and experimentally compared with radium, which is already well established in the field. Exposure technique charts presenting resolution sensitivity, and half-value layers for thicknesses up to 3 in. of aluminum, zinc, iron, tin, copper, and lead are given for the 3 sources. It is concluded that Ta^{182} behaves almost in the same manner as radium. Co^{60} offers better radiographic qualities in the case of heavier metals partly due to the greater intensity per unit volume. Both Ta^{182} and Co^{60} give better radiographic resolutions than radium. 9 references.

2171 An investigation on hot-wire vacuum gauges. III. Hans von Ubisch. Arkiv Mat. Astron. Fysik 36 A, No. 4 (1948) 14p. (See also NSA 2-2066).

The behavior of the manually operated "balanced bridge" circuit is discussed briefly and particular attention is given to high pressures. The "balanced bridge" is replaced by a circuit which is automatic and safe. The calibration curves of a gauge are given for hydrogen, air, carbon dioxide, and argon. (The range in air extends from some thousandths to 50 mm of mercury.) Since this gauge can read heat conductivities at high pressures, its possible applicability to gas analysis is noted. Comparisons were made between these calibrations and those described in two earlier papers (Arkiv Mat. Astron. Fysik 34 A, No. 14 (1947); 35 A, No. 28 (1948)) in order to draw general conclusions. A conversion factor is introduced, which makes it possible to calculate the approximate calibrations for other gases from the calibration for air, provided the pressures are below certain limits. A survey of conversion factors is given.

2172 On the relation between the thermal conductivity of rarified gases and the sensitivity range of Pirani gauges. J. A. H. Kersten. Physica 14, 567-8(1948) Dec. (Letter to the editor).

It is noted that for sufficiently long mean free paths, the Pirani gauge fails. The upper limit at which this gauge may be used can be shifted to higher pressures, not by decreasing the wire-to-wall distance, but by reducing the diameter of the filament. Experimental data are given which confirm this.

2173 Pressure and vacuum joints. J. R. Fawcett. Mech. World Eng. Record 126, 439-42 (1949) Oct. 14.

The characteristics and construction of various types of pressure and vacuum joints are discussed. Diagrams are shown and the range of applicability of each type is noted.

2174 Time constants for vacuum gauge systems. S. A. Schaaf and R. R. Cyr. J. Applied Phys. 20, 860-3(1949) Sept.

Assuming molecular flow, an analysis of a typical vacuum system is made and formulas are obtained for the response time and the pressure difference. The vacuum system analyzed consists of a vacuum gauge connected to the gas by a length of tubing, usually with an orifice of diameter smaller than that of the tubing at the end. The interior surface of this system will outgas at a fairly constant rate for a long period of time so that an equilibrium state will be reached with a definite non-constant pressure distribution along the tubing. The response time constant for the system to come to equilibrium and the difference in pressure between gas and gauge are functions of the outgassing rate and the geometry of the system. It is shown that there is an optimum value of the tubing diameter for a given orifice diameter, gauge volume, and length of tubing. This optimum is rather

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critical; if the diameter is too small, response time constants of the order of hours may result. Experimental work has been done and the results compared with theory. 8 figures.

MINERALOGY, METALLURGY AND CERAMICS

2175 Investigation of bonding between metals and ceramics. I. Nickel, cobalt, iron, or chromium with boron carbide. H. J. Hamjian and W. G. Lidman. National Advisory Committee for Aeronautics Technical Note, NACA-TN-1948. Sept. 1949. 24p.

A qualitative investigation was made of the bonding phenomenon in ceramals (mixture of metal and ceramic) after exposure at temperatures above the melting temperature of the metal constituent. Simple bonding experiments were made to indicate the compatibility of various metals and a ceramic to form a ceramal. The temperature, time at temperature, and atmosphere suitable for sintering of the ceramal were indicated by the results of preliminary experiments. The bonding experiments conducted with boron carbide and each of four metals showed that cobalt, iron, and nickel formed a bonding zone between the metal and the ceramic and that chromium showed satisfactory physical wetting characteristics on the ceramic.

2176 Radioactive and electrical logging. V. J. Mercier. World Oil 129, 128-32(1949) Oct.

The author discusses radioactive and electrical logging and presents the advantages and limitations of each method. The radioactivity log is composed of two curves: (a) γ-ray curve (natural radioactivity) and (b) neutron curve (artificial radioactivity). The former is a measure of the relative natural radioactive emission of the adjacent rocks and the latter is a measure of the secondary emission obtained by subjecting the adjacent formation to a bombardment of neutrons.

2177 The uranium-manganese and uranium-copper alloy systems. H. A. Wilhelm and O. N. Carlson. AECD-2717, nd. Decl. Sept. 30, 1949. 20p.

The uranium-manganese system has been investigated by thermal, microscopic and x-ray methods. Two compounds, U_6Mn and UMn_2, have been identified from x-ray and microscopic data. From thermal data and microstructures it has been established that U_6Mn is formed by a peritectic reaction at 726°C (1335°F), while UMn_2 is stable with a melting point of 1120°C (2050°F). There is a eutectic between these two compounds at 6.0 wt. % manganese and 716°C (1287°F). A second eutectic existing at 55% manganese between UMn_2 and Mn has a eutectic temperature of 1035°C (1870°F). It has been estimated from microstructures that the maximum solubility of Mn in γ uranium is less than 1%. The solubility decreases in the β region with a eutectoid at 0.25% Mn and 626°C (1155°F). Although the solubility of uranium in manganese has not been investigated thoroughly, there is evidence for some solubility. In the uranium-copper system one compound, UCu_5, has been identified. This compound decomposes peritectically at 1052°C (1925°F), oxidizes slowly in air, is extremely brittle, and has a density of 10.6 g/cc. It is face centered cubic with a_o = 7.0208 A. A eutectic exists between the compound and pure copper at 75 wt. % Cu and 950°C (1740°F). Liquid immiscibility occurs between uranium and the compound. There is no evidence of solid solubility of Cu in U, U in Cu, or of either primary constituent in the compound.

2178 The properties of zirconium. Francis W. Boulger. AECD-2726, Mar. 15, 1949. Decl. Oct. 18, 1949. 83p.

A critical review of the information (published up to February, 1949) on properties of zirconium, with estimates of the uncertainty in the values is presented in this report. The following topics are treated: mass, thermal properties, electrical properties, optical and thermionic properties, magnetic properties, chemical properties, corrosion, crystal structure, mechanical properties, special testing, zirconium alloys, working data, atomic and nuclear properties. 97 references.

MINERALOGY, METALLURGY AND CERAMICS (continued)

2179 The metallurgy of beryllium. A. R. Kaufmann, P. Gordon, and D. W. Lillie. AECD-2727, nd. Decl. Sept. 14, 1949. 130p. Proposed for publication in Trans. Am. Soc. Metals.

It is indicated that present methods are still far from producing a beryllium of any large degree of ductility at room temperature. Properties of flake and cast extruded materials show a high degree of directionality which could be considered in any engineering applications. Of the two, the flake metal shows better mechanical properties, but has the drawback of higher cost. Materials produced by powder metallurgy methods eliminate the directionality factor. The latest developments along these lines have not been tested, but the best of the earlier samples investigated indicates that considerably better properties can be developed in powder products than in the transverse direction in any extruded material. Corrosion resistance of powder materials tested so far has been inferior, but improvement should be possible. It is the authors' opinion that serious consideration should be given to powder products where multidirectional stresses are involved. For high temperature uses up to 700°C beryllium shows considerable promise, particularly where weight saving or specific nuclear properties are desired. Above 700°C corrosion in air becomes a serious factor and protective atmospheres are necessary. Directional factors must be considered in high temperature applications also. It seems unlikely that any major improvement in room temperature properties will be produced by methods of extreme purification or by alloying. It is recommended that future efforts be directed toward refinement of methods of working and treatment to produce optimum properties in the ranges indicated, toward methods of eliminating as much as possible the directionality factor, and toward improvement of physical properties and corrosion resistance at elevated temperatures. 29 references.

2180 Kinetics of the reactions of titanium with O_2, N_2 and H_2. Earl A. Gulbransen and Kenneth F. Andrew. J. Metals 1, 741-8(1949) Oct.

A study of the thermodynamic equilibria of the several gas phase reactions of titanium with O_2, N_2, water vapor, CO, and CO_2 show the following results: (1) TiO_2, TiN, and TiC are stable at all temperatures up to the transition temperature calculated in this study; (2) from a thermodynamic point of view titanium will remove O_2, N_2, CO, and CO_2 at the lowest pressures used in high vacuum technique; and (3) the reactions of H_2O and CO_2 to form the oxide and H_2 and CO, respectively, are possible up to 800°C and perhaps higher in vacuums of the order of 10^{-7} mm of Hg. Three tables, 14 figures, and 48 references are included.

2181 Metallurgical and mining problems in atomic energy. Sir John D. Cockcroft. Mining J. (London) 233, 857-60(1949) Sept. 17.

A description is given of one type of nuclear reactor and the method of controlling the neutron production by use of boron carbide rods. A brief discussion is given on plutonium, thorium, beryllium, zirconium, and the effects of radiation on metals. Some of the problems in the development of atomic energy involving the mining engineer and metallurgist are presented.

2182 Preparation and casting of beryllium melts. J. G. Kura, J. H. Jackson, M. C. Udy, and L. W. Eastwood. J. Metals 1, 769-78(1949) Oct. (see also NSA 2-1221).

The common difficulties encountered in the casting of metals and some of the physical and chemical characteristics of beryllium are presented in order that a better understanding might be had of the special techniques which are involved in melting and casting beryllium metal. The main points of interest are the controlled atmosphere furnace and the melting and casting of large or small, beryllium heats. The furnaces are heated by induction and, in large scale melts, a graphite bonded silicon-carbide lining has proven most successful.

MINERALOGY, METALLURGY AND CERAMICS (continued)

2183 Conference on radioactive ores. A. K. Snelgrove, ed. Michigan College of Mining and Technology. May 6, 1949. 33p.

At this conference the following papers were presented: Domestic uranium program of the United States Atomic Energy Commission, by Muriel Mathez; Pitchblende—the primary source of uranium, by Phillip L. Merritt; The geologic environment of primary vein deposits of uranium, by Donald L. Everhart; Uranium deposits of the Canadian shield with emphasis on the Theano Point, Ontario, discoveries, by A. H. Lang; Geiger counter reconnaissance in upper Michigan, 1948, by C. Ernest Kemp; Prospecting for uranium with portable Geiger-Mueller equipment, by F. W. Stead; Prospecting on state land in Michigan, by F. G. Pardee.

2184 Evaluation of the uranium content of minerals by the measurement of the nuclear radiations. J. Thommeret. J. phys. radium 10, 249-52(1949) July-Aug.-Sept. (in French).

A brief report is given of a direct method of estimating the uranium content of minerals free of thorium by means of two activity measurements made with two Geiger-Müller counters. The method is applicable to all the minerals which are in the nautral state or have undergone mechanical treatment such as washing or flotation. Tabulated data which were obtained by this method are given for a number of minerals; these are compared with the results of chemical determinations of the uranium content and the absolute and relative errors are tabulated.

2185 On a new kind of radioactive inclusions in igneous rocks. René Coppens. Compt. rend. 228, 1938-40(1949) June 20 (in French) (See also NSA 3-352; 3-1679).

In previous notes (Compt. rend 228, 176 and 1218(1949)) two sorts of radioactive inclusions in igneous rocks, as recorded on photographic plates, were described: (1) very small (several microns) and strongly radioactive inclusions containing U and Th, (2) crystals of undetermined species, about 1 mm large, containing about 1% Th, and no U. The present note is a report on a third kind of inclusions, observed in a sand from Brittany and in a granite: having an area of several hundredths of mm^2, they are strongly radioactive; they contain Th, but little or no U; the Th content, which is about 76%, corresponds to pure thorite $ThO_2.SiO_2$.

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2186 The neutrinos from the sun and the source of the earth's heat. D. Saxon. AECU-543 (UAC-137), nd. 4p.

The role of the sun's neutrinos in the heating of the earth is considered. The following inverse β reaction: $e^- + H^1 \rightarrow n + \nu$ has been tried using a small Van de Graaff generator. A cross section limit of $\leq 2.5 \times 10^{-37}$ cm^2 was obtained. The neutrino absorption /cm^3/sec in the earth has been plotted as a function of the interaction cross section. Assuming the equivalence of the observed cross section to that for neutrinos it is indicated that at most 4% (and probably only 1%) of the observed earth's heat losses could be attributed to the absorption of the sun's neutrinos. Further assumptions indicate that the present result eliminates the sun's neutrinos as a significant source of the earth's heat.

2187 Cosmological application of relativity. Georges Lemaître. Revs. Modern Phys. 21, 357-66(1949) July.

In discussing the application of relativity to cosmology, the following are treated: (1) time as a coordinate and the introduction of proper time through a metric of space time; (2) a geometrical description of matter, with the cosmical constant as a second constant demanded by the logical structure of the theory; (3) a detailed computation of the gravitational equations for a general non-static field of spherical symmetry; (4) Schwarzschild's and de Sitter's solutions free from artificial singularities; (5) map representation of elliptical space and expanding space, Friedmann's equation and its reduction to elliptic functions and numerical results; (6) geodesics of space time and this

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application to proper velocities and red-shift, a discussion of the time scale, the numerical value of the cosmical constant and data on density; (7) the use of statical coordinates and the instability of Einstein's universe when no restriction is imposed on the symmetry of fluctuations, formation of the nebulae from fast-moving clouds of gases; (8) a discussion of the problem of the clusters of nebulae; (9) the cosmic rays as remnants of primitive matter and an explanation of the large amount of hydrogen and helium in the stars.

2188 A cloud-chamber study of extensive air showers at 3260 meters elevation. W. W. Brown and A. S. McKay. Phys. Rev. 76, 1034-45 (1949) Oct. 15.

The penetrating particles in extensive air showers have been observed in a cloud chamber under 6 in. of lead at an elevation of 3260 m. If a group of air showers is selected in such a way that their cores are for the most part located between 4 and 24 m from the chamber, the penetrating particles are seen to consist mainly of μ-mesons which have been produced in the air above the apparatus. If a group of air showers is selected so that most of their cores are located < 6 m from the chamber, there are again many μ-mesons and in addition there is evidence for local production of penetrating particles in mixed showers and high energy nuclear disintegrations produced by both neutral and ionizing penetrating particles. Thus, evidence exists that high energy neutral particles and highly interacting ionizing particles make up an appreciable portion of the penetrating particles in the cores of air showers. There are more cascades of energy $> 10^8$ ev under the lead shield than can be accounted for by the radiation and "knock-on" processes of the observed number of mesons.

2189 Cosmic-ray experiments at high altitudes over a wide range of latitudes. A. T. Biehl, H. V. Neher, and W. C. Roesch. Phys. Rev. 76, 314-32(1949) Oct. 1.

A number of experiments with cosmic-ray telescopes (Millikan et al, Phys. Rev. 66, 295(1944)) on the properties of cosmic rays are reported. The data were taken during B-29 flights using three nearly equally spaced trays in triple coincidence, each of which contained eight Geiger-Müller counters. These include taking data on the latitude effect of the following, along the 80th geographic west longitude from 64° geomagnetic north to the geomagnetic equator, all at a constant pressure altitude of 30,000 ft (3.10 m of water equivalent): (1) intensity at the vertical without and with lead absorber; (2) intensity at 45°W and 45°E both without and with lead absorber; (3) total ionization intensity; (4) extensive showers. Also measured at 48°N and at the geomagnetic equator were the following: (1) zenith angle effect both without and with lead absorber; (2) intensity vs air pressure without and with lead; (3) extensive showers vs air pressure, and (4) local showers. In addition to the above, the variation in azimuth of the cosmic-ray intensity was measured with the various telescopes tipped at 22½°, 45°, and 67½° to the vertical at an elevation corresponding to 2.35 m of water equivalent at the geomagnetic equator. Two lead thicknesses were used, 10 and 20 cm, inserted between the counter trays. These experiments throw new light on the nature of the primary radiation and on the interaction of the primary particles with the matter through which they pass.

2190 Cosmic ray instrumentation. R. D. Sard. Science 110, 360-61(1949) Oct. 7.

The ionization chamber is discussed in its applications to cosmic ray research and various recent developments in the other instruments used in cosmic ray investigations are mentioned. It is noted that, from the standpoint of instrumentation, the most important characteristics of cosmic rays are the following: (1) low intensity, (2) heterogeneity in composition, energy, and direction, and (3) relative constancy. The last-mentioned of these features permits the time extension of cosmic-ray experiments and tends to partially compensate for the difficulties which arise from low intensities and heterogeneities.

2191 Decay of a heavy τ-meson into three lighter mesons. S. Power. Phys. Rev. 76, 865-6 (1949) Sept. 15 (Letter to the editor).

The evidence for the existence of the τ meson (of mass 900 m_e) is noted and calculations are made for the disintegration process $\tau \rightarrow 3\pi$, assuming the virtual creation and annihilation of inter-

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mediate nucleon pairs. The likelihood of the latter is suggested by (1) if the τ meson exists it must be created by the primary protons of the cosmic rays, suggesting a strong coupling to nucleons, and (2) π mesons appear to be strongly coupled to nucleons. Considering both meson-type as pseudoscalar, each being coupled to nucleons with pseudoscalar coupling, calculations are made by means of the Feynman diagrams. By means of Pauli's regulator functions, recently described by Steinberger the logarithmic divergence obtained is removed. Taking the mass of the τ meson to be 900 m_e and that of the π meson as 285 m_e the process $\tau + \rightarrow \pi^- + \pi^+ + \pi^+$ is found to have a reciprocal lifetime

$$\tau^{-1} = \left(\frac{g_\pi 6}{(\hbar c)^3}\right) \cdot \left(\frac{g_\tau 2}{\hbar c}\right) 5, 10^{11} \text{ sec}^{-1}$$

This seems a fairly reasonable result, in keeping with the experimental lower-limit for the lifetime, $\tau \geq 10^{-11}$ sec suggested by an analysis of Powell's photograph. The alternative process of disintegration suggested by Powell, viz. $\tau \rightarrow \pi + \mu + \mu$, has also been considered by the same methods. Here τ and π are considered to be spin -0, pseudoscalar particles, as in the previous case; the μ mesons, which it is now known are very weakly coupled to nucleons, are considered as spin $-1/2$ particles, which are coupled to nucleon pairs by a Fermi-like interaction. This results in the following value for the reciprocal lifetime of the process

$$\tau^{-1} = \left(\frac{g_\pi 2}{\hbar c}\right) \cdot \left(\frac{g_\tau 2}{\hbar c}\right) 2, 10^2 \text{ sec}^{-1}$$

which seems too long. Various arguments are advanced which lend favor to the first of the two processes investigated. Calculations are also made of the lifetimes of the processes competing with the process $\tau \rightarrow 3\pi$. It is noted that the process $\tau^+ \rightarrow \pi^+ + 2\gamma$ seems to have roughly the same degree of probability, although it has not been observed experimentally.

2192 The detection of heavy particles in the primary cosmic radiation. Martin A. Pomerantz and Frank L. Hereford. Phys. Rev. 76, 997-8(1949) Oct. 1 (Letter to the editor).

Preliminary results are given on the use of a new technique which has made possible the selective detection of the charged components of cosmic radiation; the composition of the primaries has been established and heavy particles have been discovered. The results, originally described only in Navy reports (Phys. Rev. 75, 1316(1949)) have subsequently been confirmed by investigations involving photographic plates and cloud chambers (Freier et al, Phys. Rev. 74, 213(1948)). The method utilizes G-M counters filled under conditions exploiting the dependence of the probability of discharge upon specific ionization. The combination of such counters into a coincidence train, and the establishment of a minimum range through interposed absorber, result in a device capable of discriminating violently among different types of particles. Results are tabulated for E^4 (the expected counting efficiency) for various particles penetrating the terrestrial magnetic field. They were obtained in a typical flight in which four counters, containing H_2 at a pressure of 6 cm of Hg, were used in coincidence. It was found that for particles of R.P.I. (relative primary ionization) of unity, E^4 = 0.02 whereas for helium (R.P.I. = 4), E^4 = 0.50 and for lithium or heavier particles (R.P.I. $\geq$ 10), E^4 = 0.96. It is noted that the experimentally-observed counting efficiency near the "top of the atmosphere" equal to 0.23 $\pm$ 0.03 should be compared with that of 0.02 expected for a primary radiation consisting entirely of protons. Equations are given which illustrate the method used for analyzing the data. It is seen that (k - 1) flights determine the relative intensities of k types of particles. Results have since been obtained which indicate that approximately one-third of the incoming cosmic rays are α particles, and the remainder predominantly protons, with a small percentage of particles having higher atomic numbers. The relative frequency of out-of-line events compared with that of events produced by single particles makes it improbable that spurious effects are responsible for the high efficiencies observed. Further flights using counters filled at different pressures and various absorber thicknesses are in progress.

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2193 The energy spectrum of the decay particles and the mass and spin of the mesotron. Robert B. Leighton, Carl D. Anderson, and Aaron J. Seriff. Phys. Rev. 75, 1432-7 (1949) May 1.

Energy values determined from curvature measurements of 75 cloud-chamber tracks of decay particles of cosmic-ray mesotrons at sea level, in a magnetic field of 7250 gauss, are reported. The observed spectrum extends from 9 to 55 Mev with an apparently continuous distribution of intermediate energy values and a mean energy of 34 Mev. The shape of the spectrum and the value of its upper limit are strong evidence that the mesotron disintegrates into an electron and two neutrinos. It is concluded that the mesotron has half-integral spin. The value of the observed upper limit of the energy spectrum corresponds to a mass value of the mesotron equal to 217 ± 4 electron masses.

2194 Erratum: The production of mesons by photons and electrons. Herman Feshbach and Melvin Lax. Phys. Rev. 76, 689-90(1949) Sept. 1 (Letter to the editor) (See also NSA 3-1240).

It is noted that the discussion presented in a previous article (Phys. Rev. 76, 134(1949)) applies only to the production of positive mesons (by photons and electrons) where the corrections due to the neglect of the relativistic terms in the meson-nucleon Hamiltonian are negligible.

2195 Experiments with nuclear-track emulsions sensitive at minimum ionizing power. A. C. Coates and R. H. Herz. Phil. Mag. 40, 1088-93(1949) Oct.

The angular distribution of straight-line tracks due to high energy cosmic ray particles at sea level and their number/cm^2/day at sea level and below an absorber (equivalent to 60 m of water) have been investigated. Slow electron tracks are recorded at a rate of 10^4/cm^2/day in a 200μ thick emulsion. The sensitivity of the emulsion to particles at minimum ionization does not change at low temperature (−80°C), although a decrease of 24% was found for x-ray exposures at −80°C as compared with room temperature. A number of pair formation tracks produced by a 25-Mev synchrotron have been observed. In all cases but two, one particle (presumably the positron) stops in the emulsion before slowing down. Two examples of elastic collisions between particles at minimum ionization and electrons and the formation of a multiple star are discussed.

2196 Extensive air showers at high altitudes. Henry L. Kraybill. Phys. Rev. 76, 1092-99 (1949) Oct. 15.

The latitude dependence, density properties, and lateral extension of extensive cosmic-ray air showers have been studied at 9200 m elevation, with coincidence counters in a B-29 airplane. On a flight between 0° and 63°N geomagnetic latitude, no significant variation of shower frequency with latitude has been detected. Relations between the counting rates of coincidence counter sets of different orders from threefold to ninefold are in agreement with a power law density spectrum for the showers, with constant negative exponent. The measured value of this exponent is 1.73 ± 0.04 at 9200 m, m, 1.82 ± 0.07 at 11,000-12,000 m, and 1.53 ± 0.07 at 720 m. The counting rate of a threefold coincidence counter set was found to decrease 33% as the total spread of the counters was increased from 2.8 m to 13 m at 9200 m altitude. The corresponding decrease at 720 m is 21%. The altitude dependence of the extensive showers was measured up to 12,300 m, and a definite maximum shower rate has been found near an altitude of 8000 m. 17 references.

2197 The lateral structure of cosmic-ray air showers. G. Cocconi, V. Cocconi Tongiorgi, and K. Greisen. Phys. Rev. 76, 1020-33(1949) Oct. 15.

The lateral distributions of the electrons and penetrating particles in extensive cosmic-ray air showers have been measured directly, and as a function of the size of the showers. No evidence was found for multiple cores in showers. The lateral distribution of the electrons was found to agree well with that calculated by Molière, taking into account only coulomb scattering of the electrons. The density of penetrating particles at a given distance from the core was found to be proportional to that

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of the electrons. The ratio of penetrating particles to electrons seems to increase slowly with distance from the core, but changes only by a factor of about 2 between 5 and 100 m from the core, while the electron density decreases by a factor of about 100. Evidence was obtained that most of the penetrating particles reached the apparatus as single, independent particles from the air, but that about 1/4 of the events in which penetrating particles were detected involved groups of particles that were probably locally produced in the lead.

2198 Magnetic storms and cosmic-ray intensity. H. R. Sarna and Om Parkash. Nature 164, 588-9(1949) Oct. 1 (Letter to the editor).

From February to April, 1947, data were taken on the cosmic-ray intensity with a triple counting vertical telescope (Indian J. Phys. 22, 19(1948)). It was found that the correlation with changes of magnetic intensity was slightly positive, although below the statistically significant level. During magnetic storms the correlation was more marked, and both positive and negative correlations were obtained.

2199 A method of calculation of the ratio between the masses of π and μ mesons. G. Lovera. Nuovo cimento 6, 229-30(1949) May (Letter to the editor)(in Italian).

In connection with the recent determinations of the ratio between the masses of π and μ mesons, which are based on a counting of grains along tracks in photographic emulsions, the author refers to the following formula published by him in Atti accad. nazl Lincei 2, 51(1947), and Nuovo cimento 3, 320(1946): $\lambda = KE/m + t$, where λ is the distance between neighboring grains, E is the energy of the ionizing particle, m is its mass, K and t are constants depending on the emulsion type and the units adopted. Since E can be expressed in terms of m and of the range of the particle in the emulsion, the foregoing formula can be used for the calculation of the ratio between two masses, such as those of π and μ mesons, or those of a meson and the proton.

2200 New methods of determining the absolute intensity of cosmic rays in the atmosphere and the residual ionization in ionization chambers. Victor F. Hess and Roger P. Vancour. Phys. Rev. 76, 1205-8(1949) Oct. 15.

The portable Gish-Sherman ionization meter in connection with four geometrically similar cylindrical ionization chambers of different size was used for determining (1) the cosmic-ray intensity at sea level when the apparatus is completely shielded from local radiations by 10 cm of iron and (2) at the same time a value for the residual ionization produced by spurious α particles from the walls of the chambers. Two methods to obtain this end are described: one using all four chambers and the other using the largest chamber and varying the pressure of the filling gas. Plotting the observed ionization versus the ratio "surface: volume" gives a straight line which, when extrapolated for infinite volume, leads to the value representing the ionization produced by cosmic rays without the secondaries from the wall.

2201 Nuclear disintegrations produced by cosmic rays. J. B. Harding, S. Lattimore, and D. H. Perkins. Proc. Roy. Soc. (London) 196A, 325-43(1949) Apr. 7. (See also NSA 2-1767).

Measurements have been made on the energy and angular distributions of the charged particles from disintegration "stars" produced in the silver and bromine nuclei of photographic emulsions exposed to cosmic radiation. Most of the observations were taken from plates exposed in mountain stations on the Jungfraujoch (3,457 m) and at Chamonix (3,650 and 4,400 m). The recording characteristics of the emulsions used, and the methods of identifying the tracks of the various types of particles present in the disintegrations are discussed and observations on the energy and angular distributions of the particles are described. The observations extended over a wide range of excitation energies (100-700 Mev). The energy spectra and angular distributions of the protons can be explained in all cases by simple evaporation theory. This energy distribution shows also a high-energy

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tail consisting of direct "knock-on" protons and slow mesons. At high excitation energies the α particles exhibit collimation effects which are probably due to localized "boiling" or a form of fission. A mechanism for the production of a multiple disintegration in a silver of bromine nucleus is described which is based on the data obtained. 16 references.

2202 Nuclear explosions. George Thomson. Proc. Roy. Soc. (London) 196A, 311-24(1949) Apr. 7.

The origin of the stars observed in photographic plates and their relation to analogous phenomena observed in Wilson cloud chambers is discussed. The experimental data and theories of various investigators are reviewed and several typical photomicrographic plates are shown. Among the topics reviewed and discussed are: (1) the frequency of star production in different media; (2) the artificial production of stars; (3) mesons in stars; (4) the origin of stars; and (5) the distribution of stars over the surface of plates. 20 references.

2203 Nuclear interactions of cosmic rays. Bruno Rossi. MIT Technical Report No. 26. Apr. 4, 1949. 73p. (NP-891).

The report describes and correlates various experimental results on the nuclear interactions of cosmic rays obtained by means of cloud chambers, Geiger-Mueller counters, pulse ionization chambers, photographic emulsions, and slow neutron detectors. 56 references.

2204 Nuclear transmutations produced by cosmic-ray particles of great energy. Part II. Observations at high altitudes by means of free balloons. U. Camerini, T. Coor, J. H. Davies, P. H. Fowler, W. O. Lock, H. Muirhead, and N. Tobin. Phil. Mag. 40, 1073-88 (1949) Oct.

Data obtained using "electron-sensitive" photographic emulsions exposed to cosmic radiation in balloons at altitudes up to 130,000 ft are described. The investigations made were similar to those previously reported for lower altitudes (Brown et al, Phil. Mag., 40, 862(1949)). It is shown that, at ~ 75,000 ft, the radiation which leads to the production of "stars" is made up of charged and neutral particles of which the directions of motion are more widely dispersed than at lower depths in the atmosphere; in addition high energy processes are relatively more frequent than at 11,000 ft. By making measurements of the deviations in the tracks of fast particles due to coulomb scattering, it has been possible, in cases favorable for measurement, to give estimates of the energy of the particles, or to determine minimum values for this quantity. In four out of the seven cases which have been measured, the shower particles have been found to be less massive than the proton. It is shown that balloon flights give favorable conditions for studying the generation of π-particles in matter in the vicinity of the plates, and of estimating the rate of production of mesons in the energy range below ~ 60 Mev. An event is described which appears to be due to the impact of a chlorine nucleus ($z = 17 \pm 2$), with one of silver or bromine. The primary particle is almost completely dispersed into its component nucleons. Photo-micrographs are given of characteristic examples of the nuclear transmutations under discussion.

2205 On the correlation between Yukawa particle and meson. T. Inoue and S. Ogawa. Progress Theoret. Phys. 3, 319-20(1948) July-Sept. (Letter to the editor).

Recent experimental investigations are discussed in terms of the recently proposed two-meson hypothesis (Sakata, Progress Theoret. Phys. 1, 143(1946)) which distinguished between the mesotron ($m^{\pm}$, light or cosmic-ray meson, Fermi-particle) and the Yukawa particle ($Y^{\pm}$, heavy or nuclear meson, Bose-particle). The results obtained indicate that the nuclear force and the β decay of the nucleus are due to the Yukawa particle (pseudoscalar field) with the following coupling constants; $g^2/\hbar c \sim 10^{-1}$ (nuclear force), $g'^2/\hbar c \sim 10^{-13}$ (β decay). (The mass of the Yukawa particle (300 ~ 400 m) is taken from the recent experimental data on the nuclear force-range). It is also concluded that the Yukawa particle decays into the mesotron by the process $m^{\pm} \underset{\sim}{\overset{(\gamma)}{=}} Y^{\pm}$ + neutretto. An expression for the decay probability of this process is given and it is noted that the process corresponds

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to the μ decay of a π meson. An expression for the capture probability of the charged mesotrons by nucleons is also given. It is noted that this process of meson capture is accompanied by the emission of neutral mesons of 180 m_e mass, so the experimental fact that "stars" are rarely found in meson capture, is explained (Piccioni, Phys. Rev. 73, 81(1948)). The β disintegration of cosmic-ray mesons occurs through the combined processes of

$$e \overset{(g')}{=} Y^- + \gamma, \text{ and } m^{\pm} \overset{(\gamma)}{=} Y^{\pm} + \text{neutretto.}$$

However, the lifetime thus obtained is too long. If, as suggested by Anderson (Phys. Rev. 72, 724 (1947)), a direct process is also assumed in which a charged mesotron decays into an electron and two neutrinos, the results are in agreement with the experimental data.

2206 On the density spectrum of extensive showers at sea level. M. M. Addario and C. Milone. Nuovo cimento 6, 294-6(1949) July (Letter to the editor)(in Italian).

Densities of extensive atmospheric showers, down to 10^3 m^{-2}, were studied using counters of 1.6×10^{-2} m^2 and 10^{-3} m^2 area, placed at the vertices of two interlocked triangles of 3-m side-length. The exponent γ in the density-spectrum function was calculated with the aid of the formula

$$\gamma = \frac{d \log N_3(S)}{d \log S},$$

where $N_3(S)$ denotes the frequency of triple coincidences in counters of area S. The value found was $\gamma = 1.504 \pm 0.05$. The results show that the density spectrum at 10^3 m^{-2} follows the law found for smaller densities by Cocconi et al (Phys. Rev. 70, 841(1946) and 75, 1058(1949); Nuovo cimento 3, 50(1946)).

2207 On the measurement of slow neutrons in the cosmic radiation on a B-29 plane. Luke C. L. Yuan. Phys. Rev. 76, 1268(1949) Oct. 15 (Letter to the editor).

In previous investigations of cosmic ray neutron intensities (Yuan and Ladenburg, Bull. Am. Phys. Soc. 23, No. 2, 21(1948)) at altitudes of about 30,000 ft, which were made by means of two identical proportional counters filled with enriched boron trifluoride, one bare and one shielded with cadmium, the cadmium difference counts obtained were much higher than the free-space measurements carried out by means of free balloons. In the aforementioned experiments the counters were in the navigator's compartment in the front of the plane. Further data which have been taken with the counters located in the tail of the plane seem to indicate that the massive rubber tire of the nose wheel is the probable source of the excessive number of slow neutrons obtained in the earlier experiments. Presumably, a considerable fraction of fast neutrons in the atmosphere was slowed down by the rubber and was consequently detected by the slow neutron counters.

2208 On the nature and the number of penetrating particles generated by cosmic rays through nuclear explosions in lead. A. Lovati, A. Mura, G. Salvini, and G. Tagliaferri. Nuovo cimento 6, 291-3(1949) July (Letter to the editor)(in Italian).

Experiments on nuclear explosions in lead, as recorded by the Wilson chamber, confirmed the results of a former work, made with a similar set-up, (Nuovo cimento 6, 207(1949)). The explosions are most probably caused by π mesons of the cosmic rays, and are followed, in a nuclear cascade, by new explosions, due to the new π mesons generated by the explosions. This view is corroborated by the following statistics: the average number of feebly ionizing particles, issued from the explosions in the thin lead partitions within the chamber, is four times smaller than the average number of feebly ionizing particles produced by explosions in the 10-cm lead filter above the chamber. Some preliminary observations were made on the correlation between the nuclear events and the atmospheric showers: only low-density showers, ($\sim$ 10 particles per m^2), seem to accompany the explosions.

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2209 On the radioactivity of the atmosphere. Hubert Garrigue. Compt. rend. 228, 1583-4 (1949) May 16 (in French).

An unknown radioactive substance, of a 25-hr half-life period, was recorded in July-August, 1946, by an ionization chamber at 6,000 m altitude (from an airplane), the content measured being about 2×10^{-18} curie. In July-August, 1948, at altitudes 7,300-8,700 m, the content found was much lower (0.005-0.02 curie). It is surmised that the phenomenon might be traced to the atomic bomb explosion at Bikini on July 1, 1946. Other hypotheses: meteoric origin or a nuclear reaction due to cosmic rays.

2210 On the relations between the cosmic-ray mesons and nuclear mesons. I. Y. Tanikawa. Progress Theoret. Phys. 3, 314-15(1948) July-Sept. (Letter to the editor).

The results of recent experiments, in which mesons of varying masses or heavy electrons have been observed, are tabulated and discussed. Decay schemes are proposed for the various meson-types and interaction schemes are formulated which also agree with nuclear and cosmic ray phenomena. It is deduced that the particles of the type reported by Rochester and Butler (Nature 160, 855 (1947)), Lattes et al, (Nature 160, 453, 486(1947), and Williams and Roberts (Nature 167, 102(1940) are mesons. The particles recently reported by Anderson et al (Phys. Rev. 72, 724(1947)) are assumed to be heavy electrons.

2211 On the relations between the cosmic-ray mesons and the nuclear mesons. II. Y. Tanikawa. Progress Theoret. Phys. 3, 315(1948) July-Sept. (Letter to the editor).

The previous discussion (Progress Theoret. Phys. 3, 314(1948)) of the properties of the heavy mesons and heavy electron are treated in greater detail from the theoretical point of view. The type of field (i.e., scalar, pseudoscalar, vector, Dirac), spin values, and life times have been tabulated for the aforementioned particles. The decay and capture processes are discussed in a proposed theory which is an extension of Yukawa's theory and of that previously presented by the author (Progress Theoret. Phys. 2 220(1947)) and by Sakata and Inoue (Progress Theoret. Phys. 1, 142(1946)).

2212 The zenith angle dependence of flux of the hard cosmic-ray component up to 36,000 feet. J. F. Jenkins, Jr. Phys. Rev. 76, 992-3(1949) Oct. 1. (Letter to the editor).

The counting rates of Geiger tube telescopes containing 8 and 10 cm of Pb absorber were measured in B-29 aircraft at altitudes ranging from 2,250 - 36,000 ft and at 43°N geomagnetic latitude. The telescopes used were similar to one used by Schein and Wilson (Revs. Modern Phys. 11, 292(1939)). A curve is given which shows the variation of counting rates with atmospheric pressure at zenith angles of 45° and 0°. Assuming that the directional flux, $J(\theta)$(particles cm^{-2} sec^{-1} $steradian^{-1}$), at zenith angle θ, independent of azimuth, has the form:

$$J(\theta) = J(0) \cos^n\theta, \; 0 \leq \theta \leq \pi/2,$$

$$J(\theta) = 0, \; \pi/2 < \theta \leq \pi;$$

the data obtained indicate a variation in n with the altitude. A curve which indicates the form of the variation of n with atmospheric pressure assuming $J(\theta) = J(0) \cos^n\theta$, is shown; it was obtained using the method of Greisen (Phys. Rev. 61, 212(1942)). It is noted that there is agreement between the zenith angle dependence of the total flux obtained in an earlier series of balloon flights using unleaded telescopes (Swann, Revs. Modern Phys. 11, 242(1939)), and that of the hard component at 200 g/cm^2 (atmospheric pressure).

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2213 Lambda temperatures of He^3-He^4 mixtures. B. M. Abraham, B. Weinstock, and D. W. Osborne. AECU-541(UAC-130), July 20, 1949. 4p.

It has been shown previously by the authors (Phys. Rev. 75, 988 (1948)) by comparing the isothermal flow of liquid He^3 and of liquid He^4 through a small channel or superleak that no superfluid flow occurs in pure He^3, at least down to 1.05°K. These experiments have been extended to mixtures of He^3 and He^4 in order to study the feasibility of concentrating He^3 by means of a superleak and to determine the effect of composition on the lambda temperature. The first experiment was made in an attempt to separate the He^3 from approximately 10 cc of a mixture containing 92.1% He^3 and 7.9% He^4. Subsequently, experiments were made with 2.4% He^3 and with mixtures prepared by diluting a portion of the 92.1% He^3 with He^4. Results indicate that the lambda point is depressed approximately 0.025°K per per cent He^3. It is also seen that large changes in He^3 concentration can be effected by isothermal flow through a superleak at temperatures below the lambda point of the mixture. The limit of He^3 concentration attainable by any of the various methods of separation which depend on the superfluid flow of liquid He^4 and the lack of superfluid flow of He^3 was predicted approximately. Thus, the limit at a temperature of 1.8°K is about 16% He^3, and the limit at 1.05°K is about 46% He^3. Actually, an enrichment of the residuum to 43.7% He^3 was observed in one run in which the temperature was held at 1.04°K for an extended period of time.

2214 Stabilized high voltage power supply for electrostatic analyzer. R. L. Honkel and B. Petree. AECU-558, nd. 20p.

An a-c operated power supply has been developed for the electrostatic analyzers for the University of Wisconsin electrostatic generator. Voltage is continuously variable from about 5000 to 50,000, with stability and accuracy of measurement within ± 0.01%. The stabilizer is of the usual degenerative type, but the error signal is amplified by a phototube galvanometer d-c amplifier and applied to a series impedance in the high voltage transformer primary circuit. The generator beam energy automatically follows adjustments of a low voltage potentiometer used for voltage measurements in this supply.

2215 A variable pulse and square wave generator. Robert C. Skar. AECU-561(ISC-57), nd. 8p.

The circuit described is capable of producing positive or negative rectangular voltage pulses of 45 volts amplitude into a high impedance, or 1.15 volts into a properly terminated 52-ohm coaxial cable. These pulses are variable in width from 0.2 μ sec to as wide as desired (25 μ sec in the present model) and have rise and decay times in the order of 0.12μ sec. It is possible to sharpen these pulses still more if desired by following the usual procedures used in increasing the bandwidth of video amplifiers. One limiting factor in this direction is the amount of power the designer wants to expend in the unit. In addition to the primary purpose of this instrument, it is possible to obtain 2 sharp positive pulses with an amplitude of 150 volts, whose distance apart on a time base is equal to the width of the rectangular pulse produced by the unit at the time. A parts list and circuit drawing are included.

2216 Report on an electron multiplier. H. Stoddart. AECU-564(LAMS-942), Sept. 20, 1949. 17p.

The design of the multiplier is identical with that of Allen. (Rev. Sci. Inst. 18, 739(1947)). The soldering of the Kovar glass seals to the base plate is detailed. The method used to activate the electrodes was to place the entire electrode assembly inside a long glass bell jar and heat it with r-f current induced from a coil of 11 turns of copper tubing. For the first activation no oxidation of the surfaces was attempted, but they were simply heated to a dull red (as viewed in the dark) in a good vacuum (10^{-5}mm Hg) for about 15 min. A second activation was made after no pulses of any height could be obtained from the tube when the electronic equipment was finally working. The only testing done to this date with the tube has been with α particles from plutonium. Curves indicate results of testing.

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2217 Analysis of the transient response of amplifiers with shunt feed back. C. D. Florida. Atomic Energy Research Establishment AERE-EL/R-368, Aug. 1949. 38p.

The analysis contained in this report investigates the transient response of shunt feed-back amplifiers in common use, with emphasis on the critically damped condition; and charts have been compiled which make it possible to obtain any required solution. These charts should prove of use in the design of shunt feed-back amplifiers of the type discussed and can also be used with any other system having the same basic equations if the appropriate substitutions are made. Two features which have been fairly well appreciated, but are now put on a calculable basis, are the large influence of the capacity C_2 on the transient response and the fact that the unfed-back gain of the system has an appreciable effect on the response. The first points to the need for an investigation into the self-capacity of resistors and its variation among differing types; while the second indicates that if stability of transient response is required, greater attention will have to be paid to constancy of value (electron tube) mutual conductances than is the case if only stability of feed-back gain is desired.

2218 Electronics: experimental techniques. William C. Elmore and Matthew Sands. New York, McGraw-Hill, 1949. 410p. NNES Div. V, Vol. 1.

Electronic circuits suitable for making measurements of various physical quantities, particularly those of interest in nuclear physics, are described in a series of articles written by the authors both singly and in collaboration. The topics treated included the following: circuit components, voltage amplifiers, electronic counters, oscillographs and associated equipment, testing and calibrating equipment, and power supplies and control circuits.

2219 A study of signal/noise ratio in standard linear amplifiers. T. E. Cranshaw and B. B. Kinsey (Cavendish Laboratory) BR-449, Dec. 14, 1943. 12p.

A study of the signal/noise ratio has been made for linear amplifiers of standard type, (the shortest time constant of a grid circuit is about 10^{-4} sec) using an EF 36 valve (electron tube) in the head-amplifier stage. The object of these measurements was to determine how the signal/noise ratio in a standard type amplifier, used in conjunction with an ionization chamber, varied with the valve and circuit conditions. When the stray capacities in the grid circuit of this stage are low, the noise is found to be predominately Johnson noise. In these conditions the signal/noise ratio is approximately independent of capacity. The noise level depends markedly on the magnitude of the grid leak, increasing as the resistance is lowered. Above a certain capacity, the signal/noise ratio falls away, owing to the reduction of the Johnson noise to the level of the valve noise. For any particular value of the grid leak, there is, therefore, a critical capacity below which the signal/noise ratio is constant. For a free grid (leak about 10^{10} ohms), this capacity is about 30 pF; with a leak 10^7 ohms, it is about 100 pF. The equivalent noise resistance of the valve noise, with the valve working under optimum conditions is about 8000 ohms.

2220 Mass spectrometric measurements of natural isotopic spectra. R. F. Hibbs. AECU-556(Y-472), Aug. 30, 1949. 14p.

The natural isotopic composition of nineteen stable elements (O, Ne, Si, Cr, Fe, Zn, Ga, Se, Br, Mo, Cd, In, Sn, Te, Ce, Hf, W, Hg, and Tl) has been determined with the mass spectrometer. The methods used meet the requirement of small sample consumption and are suitable for the analysis of enriched materials. Brief descriptions of the chemical preparation of compounds, the sample handling techniques, and the ions measured are included.

2221 New radioactive isotopes of dysprosium. B. H. Ketelle. Phys. Rev. 76, 1256(1949) Oct. 15 (Letter to the editor).

Two new radio-isotopes of dysprosium have been assigned following the slow neutron irradiation of dysprosium oxide which had been highly purified by ion exchange techniques; activities of 80

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hr and 140 ± 10 days were assigned to Dy^{166} and $Dy^{157 \text{ or } 159}$, respectively. The Dy^{166} was probably formed by the following series of reactions:

$$Dy^{164} \xrightarrow{n\gamma} Dy^{165} \xrightarrow{n\gamma} Dy^{166} \xrightarrow{\beta} Ho^{166} \xrightarrow[27.3\ hr]{\beta} Er^{166}$$

The β end point was determined as 0.4 Mev for the 80-hr activity and absorption curves in Cu and Ta indicated that the 140-day activity decays by orbital electron capture. The neutron activation cross section of Dy^{165} (previously known to have a 138-min activity) was determined as 5,000 barns.

2222 A note on the original isotopic composition of terrestrial carbon. Kalervo Rankama. J. Geol. 56, 199-209(1948) May.

The primordial isotopic composition of terrestrial carbon is discussed with reference to astrophysical and geological evidence on the possibilities of fractionation of isotopes. It is suggested that the original isotopic composition of terrestrial carbon corresponds to that found in meteorites, where the C^{12}/C^{13} ratio ranges from 89.8 to 92.0. As is known by earlier investigations, the inorganic processes on the earth tend to concentrate the heavy isotope, C^{13}, whereas the light one, C^{12}, is accumulated by organic processes. The isotopic composition of O, Fe, and Cu, as compared with that of C, in meteorites and terrestrial samples is discussed. 30 references.

2223 On the abundance of I^{129}, Te^{118} and Pt^{190}. Wallace T. Leland. Phys. Rev. 76, 992 (1949) Oct. 1 (Letter to the editor).

Using a 60° mass spectrometer having a design similar to that described by Nier (Phys. Rev. 52, 937(1937)), data was obtained on iodine which indicates that if I^{127} does exist in nature its abundance must be less than 3 parts in 10^6 relative to I^{127}. In addition, the existence of the new isotope Pt^{190} was confirmed and the portion of the mass spectrum in which this isotope appears is shown. The abundance of Pt^{190} was determined as 0.012% with an accuracy of about 10%, as compared with the lower value of 0.006% with a 20% accuracy reported by the discoverers of this isotope (Duckworth et al, Phys. Rev. 75, 1438(1949)). An investigation which was made using Te failed to reveal the presence of Te^{118}, but an upper limit on its abundance was placed at 0.0003%.

2224 Shipping radioactive substances. Phys. Today 2, 21-5(1949) Oct.

The problems involved in transporting radioactive materials are discussed and the Interstate Commerce Commission regulations concerning the packaging and labeling of radioactive materials are summarized. (Based on a report by Robley D. Evans. The full text will be published later by the National Research Council.)

2225 Variations in abundances of isotopes in nature. H. G. Thode. Research 2, 154-61(1949) Apr.

Various investigations of the variations in the abundances of isotopes in nature are reviewed. The following topics are discussed in some detail: (1) the differences in the chemical properties of the isotopes, (2) isotopes of oxygen, (3) isotopes of carbon, and (4) isotopes of boron and sulfur. It is noted that relatively large variations occur in the isotopic abundances of the light elements, and the necessity of mentioning the origin of the samples investigated, where values are given to better than a few per cent, is emphasized. The experimental and theoretical investigations which have been made show that these variations in isotopic abundances are significant and have important implications in physics, chemistry, biology, and geology. The changes in isotopic ratios which occur are undoubtedly related to the differences in chemical properties of isotopic substances and will depend on chemical and physical processes that occur in nature. A further means is, therefore, provided for tracing out the mechanism of natural processes and for determining the origins of certain natural materials.

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2226 The electromagnetic separation of the isotopes of mercury. C. P. Keim. Phys. Rev. 76, 1270-71(1949) Oct. 15 (Letter to the editor).

The natural isotopes of mercury have been enriched successfully in the mass spectrographs (calutrons) at the electromagnetic separation plant, Oak Ridge, Tennessee. Effort has been directed toward obtaining an enriched even-mass isotope with low odd-mass contamination, to minimize the isotope wavelength shift in the mercury spectrum, particularly the 5461A line. For this purpose the enriched sample of Hg^{202}, shown below, was obtained:

Isotope	Enriched abundance	Natural abundance
Hg 196	0.014%	0.16%
Hg 198	0.092	10.02
Hg 199	0.113	16.92
Hg 200	0.781	23.10
Hg 201	0.365	13.22
Hg 202	98.06	29.72
Hg 204	0.574	6.84

In this product the sum of the odd mass isotopes is 0.478% and the sum of the even mass isotopes is 99.522%. In addition to the Hg^{202} collection, Hg^{198} has been enriched to ~ 60%, Hg^{199} to ~ 70%, Hg^{200} to ~ 75%, and Hg^{204} to ~ 92%.

2227 Research in the field of isotopic chemistry. A. I. Brodskiy. Ukrainian Academy of Sciences. nd. 25p. (NP-938).

The conclusions drawn from more than 30 experiments on the study and use of isotopes, mainly hydrogen and oxygen, are presented in this discussion. The following topics are treated: I. separation of isotopes (obtaining heavy water, concentration of heavy oxygen, thermal diffusion, general theory of fractionating isotopes); II. Chemical uses of isotopes (isotopic exchange of hydrogen atoms, isotopic exchange of oxygen atoms, mechanism of reactions with compounds containing oxygen); III. influence of isotopes on optical properties (absorption spectra of crystal deuterates and their solutions, absorption spectrum of heavy acetone, molar refractions of water isotopes); IV. isotopic structure of natural waters (full isotopic analysis of water, atmospheric precipitations, mountain waters, arctic waters, hydrogen of naphtha). 37 references.

2228 The separation of nuclear isomers. Georges Cayas. Compt. rend. 228, 1804-6(1949) June 8 (in French).

For the separation of nuclear isomers, Segrè et al (Phys. Rev. 55, 321(1939)) and other authors have used the radioactive recoil caused by a photon or a conversion electron. The present author attempted a purely physico-chemical procedure. Ethyl bromide (50 cm^3), after having been irradiated with slow neutrons for 2 hr, was poured over 1 g amberlite IR4B, stirred, filtered, and precipitated with a small quantity of $AgNO_3$. The activity curve of the precipitate, compared to that of the precipitate obtained from a sample not treated with amberlite, showed a marked separation of Br^{80} (18 min), starting from Br^{80*} (4.5 hr).

2229 Preliminary investigation of the Westinghouse leak detector as a mass analyzer. J. Kramer and G. W. Keilholtz. AECD-2721, Aug. 8, 1949. Decl. Oct. 10, 1949. 16p.

The Westinghouse Leak Detector is a small portable mass spectrometer of conventional design with the voltages, magnetic field strength, and dimensions selected to make the instrument especially sensitive in response to He in the atmosphere drawn through it by a vacuum pumping system. A preliminary investigation has been made concerning the adaptation of the Westinghouse Leak Detector as a mass analyzer. With minor changes in the slit system and the detector unit, the leak detector has a

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resolution of one mass unit in the range 4 to 20 and two mass units in the range 20 to 30. Isotope abundance ratios can be determined in the order of ± 5%.

2230 Electron and ion beam instruments. J. G. Hutton. Gen. Elec. Rev. 52, 11-20(1949) Oct.

Four devices are discussed in which the properties of accelerated particles are utilized within the instrument for the purpose of making measurements. These include the cathode ray oscillograph, the electron microscope, the mass spectrometer, and an adaptation of the mass spectrometer, the leak detector. A brief general discussion of the properties of charged particles and the various types of sources is also included.

2231 A mass spectrometer for isotope ratio determinations. H. F. Wiley. Science 110, 354-5(1949) Oct 7.

The Consolidated-Nier isotope ratio mass spectrometer is described; this instrument makes it possible to use the stable isotopes of a number of common elements as tracers. Unlike mass spectrometers it has two collectors, arranged so that all ions of one specific mass strike one collector at the same time that all ions of another specific mass strike the other. Only gas samples can be used in the instrument, so the isotopes must be converted to CO_2, N_2, O_2, etc. before they are introduced and gas samples as small as 0.1 ml S.T.P. can be handled. A diagram is shown of the ion source, analyzer tube, and dual collector assembly of the instrument; the construction is similar to that described by Nier (Rev. Sci. Instruments 18, 398(1947)). It is noted that a permanent magnet is used in place of the usual electromagnet and associated power supply. The resolution obtained is adequate for precise ratio measurements up to about mass 70. The ratio is read to six figures and is significant to about 0.000005. It is noted that the results obtained indicate that 30 at. % enriched hydrogen, nitrogen, and carbon may be diluted to one part in 100,000 in normal material.

2232 On a mobility analyzer for gaseous ions. II. Effect of the finite thickness of the sliding ring. Paul Langevin. J. phys. radium 10, 225-34(1949) July-Aug -Sept. (in French) (See also NSA 3-1703).

A theoretical study of the motion of a gas carried along by a thick cylindrical sliding ring, pierced by horizontal slits and turning about its own vertical axis between two coaxial cylinders, is given. This is followed by a study of the electrostatic field between the sliding ring and the conducting cylinders (taken as electrodes). The coefficients are obtained for the Fourier series development of the velocity-function, taking into account the conditions at the limits, an infinite number of linear equations and an infinite number of unknowns. A convenient choice of a limited number of unknowns and equations gives a solution close enough to permit the calculation of the corrections to carry foreward to the case of the infinitely thin sliding ring previously solved in part I, using a different method. An analogous method is applied to the electrostatic problem.

2233 Report on triangle computer. H. G. Weiss. AECD-2707, June 10, 1948. Decl. Sept. 16, 1949. 11p. Proposed for publication in Rev. Sci. Instruments.

The problem is to solve for the third side of a triangle whose two sides and included angle are known. This paper describes a simple, electrical analog computer which has been developed to speed up such computation. The principle of operations, the actual circuit, and the adjustment procedure of the computer are described. The overall accuracy is indicated as being between 0.3 and 1.25%.

2234 Iterative processes. J. Blum. AECU-562(LADC-702), nd. 10p.

The present paper is based on a consideration of two articles (Hartree, Proc. Cambridge Phil. Soc. 45, 230-36(1949); Domb, ibid 45, 237-40(1949)). A definition of order as applied to an iterative process (I.P.) is set up. It is shown that an I.P. of a certain order may be obtained through a linear combination of several I.P.'s of lower order. The I.P. known as the Newton-Raphson process (N.R.P.) is expressed. It is shown by a theorem that a second order I.P. can be derived by the N.R.P. upon a suitable equation. The N.R.P. is expected to be more efficient I.P. for the equation $\phi(x) = 0$ when

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the curve $y = \phi(x)$ makes contact of high order with the tangent line at the point (X,O). A theorem shows the simple relation between the order of contact of this tangent line and the order of the N.R.P. A lemma is first proved. Theorems are utilized as (1) an immediate consequence of the lemma and the definition of order and (2) to prove the existence of an I.P. of any prescribed order which is derived from the N.R.P. and to indicate the extent to which the I.P. may fail to be unique. An extension to the N.R.P. is worked out to be a generalization of the N.R.P.

2235 A new molecular beam resonance method. Norman F. Ramsey. Phys. Rev. 76, 996(1949) Oct. 1 (Letter to the editor).

It is noted that by suitably varying the amplitude and phase of the oscillating field along the path of the beam it is possible to obtain resonance curves which are different and often more useful than those which are obtained using an oscillating magnetic or electric field which extends approximately uniformly throughout the region in which the molecular states are investigated (Rabi et al, Phys. Rev. 55, 526(1939)). The case in which the oscillating field is applied in two limited regions at the entrance and exit from the space in which the states are investigated has been investigated theoretically in some detail. In this case the formula for the transition probability induced by the oscillating field has been derived exactly and has been numerically averaged over the velocity distribution of the molecules in the beam. For the case of a magnetic moment of spin 1/2, the mean transition probability induced by an oscillating magnetic field, of such a strength as to make the transition probability at exact resonance a maximum, is shown in the immediate neighborhood of resonance. Some advantages of the new technique are noted.

2236 Nuclear cross sections for 95-Mev neutrons. James DeJuren and Norman Knable. AECD-2705, June 10, 1949. Decl. Sept. 15, 1949. 27p.

The total cross sections of twelve different elements (H, D, Be, C, N, O, Al, Cl, Cu, Sn, Pb, and U) were measured using the neutron beam from the 184-in. cyclotron operating with deuterons. Bismuth fission ionization chambers were employed as both monitor and detector in conventional "good geometry" attenuation measurements in the neutron flux emerging from the 3-in. diameter collimating port in the 10 ft thick concrete shielding. The mean energy of detection of the neutrons in this experiment is estimated to be 95 Mev. Measurements were also made with a monitor and detector placed inside the concrete shielding where an intense neutron flux over a large area was available. Attenuators of four different elements were placed in front of the detector in a "poor geometry" arrangement so that attenuation was due essentially to inelastic collisions which degrade the neutron energy below the fission threshold. A second detector was placed outside the concrete shielding in the collimated neutron beam in line with the neutron source, absorber, and first detector. Attenuation in it was caused by both inelastic and elastic scattering. By this arrangement the ratio of inelastic to total cross section could be determined directly in one experiment. The nuclear radii as calculated from the observed cross section using the theory of the transparent nucleus varied as $1.38 \times 10^{-13} A^{1/3}$ cm. In this energy range the ratios of the inelastic to total cross sections were all less than one-half.

2237 Delayed neutrons from thorium. L. G. Creveling, J. R. Hood, and M. L. Pool. Phys. Rev. 76, 946-8(1949) Oct. 1.

Thorium has been irradiated with fast neutrons from the reaction Li(d,n). The half-lives of the delayed neutron activities were found to be 55.6, 220, 4.5, 1.5, and 0.13 sec with initial relative saturation intensities of 0.279, 1.00, 2.00, 1.83, and 1.75, respectively. The intensity of the 55.6-sec activity relative to the 22.0-sec activity was found to be 1.76 times greater for thorium fission than for uranium fission.

2238 Interaction of 14-Mev neutrons with deuterons. J. H. Coon and R. F. Taschek. Phys. Rev. 76, 710-15(1949) Sept. 15.

By coincidence counting of recoil deuterons in a proportional counter telescope, the angular distribution for n-d scattering has been measured using neutrons of 14-Mev energy. The measure-

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ments covered the angular range corresponding to neutrons being scattered at angles between 180° and 70° in the center of mass system, and by extrapolation an approximate curve was obtained over all angles. Upper limits can be placed on the probability of the n-2n disintegration process for ejection of protons in the angular range from 0° to 120° in the center of mass system.

2239 Neutron diffraction by crystals. Kathleen Lonsdale. Nature 164, 205-9(1949) Aug. 6.

The new technique of neutron diffraction by crystals is reviewed with a discussion of the following topics: (1) the properties of neutrons; (2) methods of detection and counting of neutrons; (3) neutron sources; (4) the interaction of neutrons with matter; (5) experimental methods of neutron diffraction; and (6) some of the results obtained in neutron diffraction experiments. 24 references.

2240 On the polarization of slow neutrons. J. Steinberger and G. C. Wick. Phys. Rev. 76, 994-5(1949) Oct. 1 (Letter to the editor).

It has previously been suggested by the authors (Phys. Rev. 74, 1207(1948)) that the discrepancy between experimental data (Hughes et al, Phys. Rev. 73, 1277(1948)) on Bloch's polarization cross section for thermal neutrons in cold-rolled steel and the latest theoretical value (Hamermesh, Phys. Rev. 61, 17(1942)) could be removed without making any drastic alteration of the magnetic interaction law, but rather by making a critical revision of some of the factors entering into the theory. A more detailed account of this critical revision is given; it involves changes in (1) the scattering correction; (2) the calculation of the d-electron wave functions; and (3) the value used for the coherent scattering cross section of the iron nucleus. The result of the three improvements described is to bring the theoretically calculated value of Bloch's polarization cross section into quite close agreement with the experimental results.

2241 On a spherical neutron diffusion problem. L. Hansson and I. Waller. Arkiv Mat. Astron. Fysik 36 B, No. 8 (1949) 7p.

An iteration method, developed by Fermi (Ricerca sci. e ricostruz. VII - II, 13(1936)) for plane problems of neutron diffusion, has been extended to a systematic approximation method applicable to more general geometries. Approximate expressions are derived for the neutron density and the angular distribution in an infinite, non-capturing medium, surrounding a perfectly absorbing sphere. The mean free path, which is assumed to be constant, is taken as the unit of length and the scattering is assumed to be isotropic. No sources are present within finite distances from the sphere, but a spherically symmetrical flux toward the sphere is assumed to exist. Although this problem has already been treated by several authors (Marshak, Phys. Rev. 71, 443, 688(1947); Berlin, Phys. Rev. 73, 437(1948)) using different methods, unlike the other methods the procedure used by the authors can be applied to Berlin's "shadow phenomenon."

2242 Revised table of thermal absorption cross sections. C. A. Rennie and J. S. Story. Atomic Energy Research Establishment Report AERE T/R-309, Mar. 1, 1949. 5p.

The table of neutron cross sections issued originally in report AERE-T/R-259 has been revised in accordance with later data. In particular this table embodies the declassified information recently issued in report AECD-2138, and all values of thermal absorption cross sections have been obtained from declassified sources. In Appendix A the cross section per gm of the elements are listed in descending order of magnitude and in Appendix B in alphabetical order.

2243 Signs of the magnetic moments of neutron and proton. E. H. Rogers and H. H. Staub. Phys. Rev. 76, 980-1(1949) Oct. 1. (Letter to the editor).

A direct comparison between the signs of the neutron and proton magnetic moments was made by obtaining nuclear resonances in purely rotating radiofrequency magnetic fields. In addition to the relative sign, the absolute signs of these moments have been determined. The experimental method used differed principally from that used by previous investigators, i.e., Powers (Phys. Rev. 54, 827

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(1938)), Millman (Phys. Rev. 55, 628(1939)), and Bloch et al (Phys. Rev. 74, 1025(1948)), in the technique used in setting up the rotating field. The latter was derived from two pairs of crossed coils placed at right angles to each other and fed by two r-f currents differing in phase by 90°. For the same direction of the constant field, it was noted that the neutron and proton resonances occurred for opposite directions of rotation of the r-f field; from this it is concluded that the magnetic moments of the proton and neutron are opposite in sign. The absolute signs of the moments were determined by establishing the actual direction of the constant magnetic field and the true sense of rotation of the r-f field. By this means it was determined unambiguously that the proton moment is positive and the neutron moment is negative.

2244 Relative photofission cross sections of several fissionable materials. John McElhinney and William Ogle. AECD-2706, Feb. 18, 1949. Decl. Sept. 13, 1949. 38p. Proposed for publication in Phys. Rev.

The photofission excitation curve of U^{238} up to 21 Mev has been measured. An attempt has been made to determine the photofission cross-section shape as a function of bremsstrahlung energy making appropriate assumptions as to the x-ray spectrum of the betatron. It was not possible to obtain a unique solution for the cross section shape; but two possible solutions are given, both of which have a resonance peak at about 15 Mev. The photofission yield of several fissionable materials relative to U^{238} has been measured in the region of the resonance. The relative yields per atom for the substances under investigation are U^{235}, 1.49; Pu^{239}, 2.51; U^{233}, 2.49; Th^{232}, 0.257; Th^{230}, 0.847; and U^{238}, 1.00. Appendix I presents a theoretical consideration of the bremsstrahlung spectrum impingent on U^{238} in the fission chamber. Appendix II considers the response to different energy quanta of the R-thimbles used to monitor the betratron x-ray beam.

2245 On the relative yields of fission cesium isotopes. M. G. Inghram, D. C. Hess, Jr., and J. H. Reynolds. AECD-2715, June 27, 1949. Decl. Sept. 30, 1949. 3p.

This letter reports on mass spectrometric measurements of the abundances of the long-lived fission cesium isotopes. Mass spectrometer measurements were made with a surface ionization type of source in a 60° direction focussing mass spectrometer. The results tabulated are the relative yields deduced from the observed abundances of the isotopes by correcting for fractionation, neutron absorption, and radioactive decay. In order to study the activity of Cs^{135} a mass spectrographic separation of the cesium isotopes was made. Results and variations from previous available data are discussed.

2246 Symmetrical tripartition of U^{235} by thermal neutrons. L. Rosen, A. M. Hudson. AECD-2725, Aug. 29, 1949. Decl. Oct. 17, 1949. 30p.

By making use of an ionization chamber divided into three sections and a triple coincidence circuit in conjunction with either a gated ten-channel amplitude discriminator or a double coincidence circuit, it has been found possible to determine the frequency of symmetrical triple fissions in U^{235} relative to the frequency of binary fissions. The results of the experiments are that triple fissions occur to the extent of 6.7 ± 3.0 per 10^6 binary fissions in the case where the fragments come off with comparable masses. 20 references.

2247 A cloud-chamber study of fission fragment ranges in air. J. K. Bøggild, L. Minnhagen, and O. B. Nielsen. Phys. Rev. 76, 988-9(1949) Oct. 1 (Letter to the editor)

The mean ranges in air of the U^{235} fission fragments have been measured by means of a 20-cm cloud chamber, using an experimental arrangement similar to that previously used in investigations of fission fragment ranges in other gases (Phys. Rev. 71, 281(1947)). The gas mixture used consisted of air and the vapors of a mixture of equal parts of ethyl alcohol and water, the total pressure being about 20 cm of Hg. It was found that the mean ranges in air at S.T.P. were 19.5 mm and 25.4 mm for the short range and long range groups, respectively. The results obtained are discussed and compared with the work of other investigators.

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2248 Nuclear fission and atomic energy. William E. Stephens, ed. Lancaster, Science Press, 1948. 294p.

The material presented had its origin in a series of seminars on nuclear physics which were held under the auspices of the Physics Department of the University of Pennsylvania in the fall of 1945. The following topics are included: (1) the discovery and production of fission; (2) fission fragments and products; (3) secondary neutrons; (4) heavy nuclei, (5) theory and dynamics of fission; (6) chain reactions (slow neutrons and piles); (7) fast neutron chain reactions; (8) separation of isotopes; (9) chemical separation-the isolation of plutonium; and (10) the potentialities of fission techniques. In addition to the references given as footnotes throughout the text, a 21-page bibliography on fission and the transuranic elements is also given.

2249 List of nuclear constants recently determined at the Radiation Laboratory, University of California. E. K. Hyde. AECU-548(UCRL-418), Aug 17, 1949. 5p.

The following information is tabulated for isotopes of thallium, lead, bismuth, polonium, astatine, radon, and francium: certainty of mass assignment, half-life, mode of decay, branching ratios, energies, genetic relationships, and method of production.

2250 The properties of atomic nuclei. III. Nuclear energy levels Z = 11-20. D. E. Alburger and E. M. Hafner. AECU-549(BNL-T-9), July 1, 1949. 22p.

A table is presented which summarizes the energies of known excited states in 33 isotopes from sodium to calcium and which contains over 300 levels observed in radioactivity and transmutation experiments. A table of mass defects covering isotopes from atomic number 1 to 20 is also included. This report is an extension of the compilation of Hornyak and Lauritsen (Rev. Mod. Phys. 20, 191(1948)). 109 references.

2251 The binding energy of the triton. R. E. Clapp. Phys. Rev. 76, 873-4(1949) Sept. 15 (Letter to the editor).

A variational calculation of the binding energy of the H^3 nucleus has been performed using the Rarita-Schwinger interaction (square well with tensor force), as modified to include a charge-exchange factor $(-\frac{1}{3}\tau_i.\tau_j)$. This is the same problem as that studied by Gerjuoy and Schwinger (Phys. Rev. 61, 138(1942)) and by Feshbach and Rarita (Phys. Rev. 75, 1384(1949)). The same variational method was used, but a much more elaborate trial function was inserted. A denumerable series of orthogonal functions which form a complete set for the nuclear three-body problem was constructed. Although the calculations are still in progress, the binding energies resulting from the successive inclusion of one ^2S-state function and three ^4D-state functions have been tabulated and it is noted that D-states not included in the previous calculations of Schwinger, Feshbach, and Rarita make a substantial contribution to the binding energy.

2252 Classification of nuclear isomers. P. Axel and S. M. Dancoff. Phys. Rev. 76, 892-8 (1949) Oct. 1.

A classification of nuclear isomers is made on the basis of the forbiddenness of the transitions from the known nuclear isomeric states. The resultant grouping is shown to be in agreement with the Weizsacker theory of isomerism (Naturwissenschaften 24, 813(1936)) and with internal conversion theory. The predictions of internal conversion theory are also compared with the experimental values which are available for the isomers considered.

2253 Contributions to the study of nuclear isomerism. Njål Hole. Arkiv Mat. Astron. Fysik 36A, No. 9 (1948). 50p.

Following an introduction to the study of the various problems of nuclear isomerism, a description of the experimental methods applied by the author in his investigations of the isomeric nuclei of Cd, Hf, Ta, Ir, Pt, and Hg is given. All irradiations were made in a cyclotron which produces

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deuterons with energies of 6-7 Mev. A magnetic lens spectrograph constructed and previously described by Siegbahn (Arkiv Mat. Astron. Fysik 30 A, No. 20 (1944)) was used for the investigation of β and γ spectra. The radiation was measured by means of a Geiger-Müller counter of the bell type with a mica window. An account is also given of an investigation of the absorption of continuous β spectra in various materials. Some statistical considerations which are of importance for the measurements are given. The results obtained in the investigation of the aforementioned nuclei are given and compared with those obtainable from existing theories. It is concluded that all theories of nuclear isomerism which have been developed thus far give a qualitatively satisfactory explanation of the phenomenon of nuclear isomerism, but none of them is capable of describing the phenomenon quantitatively.

2254 Detection of antiferromagnetism by neutron diffraction. C. G. Shull and J. Samuel Smart. Phys. Rev. 76, 1256-7(1949) Oct. 15 (Letter to the editor).

The possibility that neutron diffraction experiments might provide a direct means of detecting antiferromagnetism has been investigated and results are given which indicate that neutron diffraction studies of antiferromagnetic materials should provide a new and important method of investigating the exchange coupling of magnetic ions. Neutron diffraction patterns which were obtained for powdered MnO at room temperature and at 80°K are shown. The room temperature pattern shows coherent nuclear diffraction peaks at the regular face-centered cubic reflection positions and the liquid type of diffuse magnetic scattering in the background. The low temperature pattern also shows the same nuclear diffraction peaks, since there is no crystallographic transition in this temperature region, and in addition shows the presence of strong magnetic reflections at positions not allowed on the basis of the chemical unit cell.

2255 A determination of the binding energy of the deuterium nucleus and of the neutron mass from the nuclear photo-effect of deuterium. Peter Meyer. Z. Physik 126, 336-43(1949) (in German).

New determinations were made of the binding energy of the deuterium nucleus and of the mass of the neutron. A proportional counter, filled with deuterium, was irradiated with γ quanta (2.620 Mev) from a RaTh preparation; the energy of the protons generated through the reaction (γ,n) was measured. The counter was calibrated by using electrons that an α particle produces while traversing a known section from the middle part of its range. The energy of the protons measured was 216.8 kev ± 1%, from which the binding energy of the deuteron is found to be 2.186 ± 005 Mev. Using this value and the best known values of the proton mass and of the mass difference $M_{H_2} - M_D$, the author finds for the neutron mass the value 1.008939 ± 0.0000066 mass units.

2256 Electric quadrupole moments of nuclei. G. J. Bene, P. M. Denis, and R. C. Extermann. Phys. Rev. 76, 1255(1949) Oct. 15 (Letter to the editor).

Gordy's rule (Phys. Rev. 76, 139(1949)) for estimating electric quadrupole moments has been extended to isotopic paris having different spin and to nuclei of nearly equal Z values. The following information was thus obtained on the nuclei noted: (1) Zn^{67} — less flattened than Cu^{65} and $Q(Zn^{67}) \sim = 0$; (2) Co^{59} — less flattened than Mn^{55} and $Q(Co) < Q(Mn)$; (3) Rb^{85} — less flattened than Rb^{87} and $Q(Rb^{85}) \sim = +30 \times 10^{-26} cm^2$; and (4) Sb^{123} — less flattened than Sb^{121} and $Q(Sb^{123}) \sim = -60 \times 10^{-26} cm^2$.

2257 The energy levels of the N^{14} nucleus. H. A. Wilson. Phys. Rev. 76, 687(1949) Sept. 1 (Letter to the editor).

The theoretical values calculated using the author's nuclear sphere shell theory (Modern Physics 3rd ed (1948), p 273) for the resonances observed in the bombardment of carbon with deuterons are compared with the observed values (Heydenburg et al, Phys. Rev. 75, 1147(1949); (Phillips et al, Phys. Rev. 76, 169(1949)); and the general agreement between the two sets of values is found to be satisfactory.

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2258 Mass defects of the lightest nucleons. A. H. Wapstra. Physica 15, 380-5(1949) May.

The mass defects of the following light isotopes have been calculated from mass spectrographic and nuclear reaction data, by means of the "least squares" method: H^2, H^3, He^3, He^4, Li^6, Li^7, Be^7, Be^8, Li^8, Be^9, and B^9.

2259 Nuclear magnetic resonance shift in metals. W. D. Knight. Phys. Rev. 76, 1259-60 (1949) Oct. 15 (Letter to the editor).

A shift from the expected values has been observed in the nuclear magnetic resonance frequencies in Li, Na, Al, Cu, and Ga, in magnetic fields ranging from 5,000-10,000 gauss; and automatic search-type r-f spectrometer (Pound, Phys. Rev. 72, 527(1947)) was used. The Li and Na resonances were observed in shavings of the respective metals in kerosene, while the Cu and Al resonances occurred in metal powders which had been suspended in melted paraffin and subsequently cooled in a mold. The Ga metal was sealed in several capillary tubes, each about one mm in diameter. It is noted that the shift for a given isotope is proportional to the resonance magnetic field (or frequency) within the limits of error, and is greater in the heavier metals, varying from 3.4 kc/sec for Li^7 to 33.3 kc/sec for Ga^{71}. The other values obtained were 10.5, 16.2, 23.7, and 25.6 kc/sec for Na^{23}, Al^{27}, Cu^{63}, and Cu^{65}, respectively. Townes' suggestion that the shift may be due to the paramagnetic effect of the conduction electrons in the vicinities of the metal nuclei is discussed. It is noted that further experimental work is being done to determine the possible existence of a shift in resonance frequency when comparing two or more salts of the same metal. Preliminary measurements show that the latter shift, if it exists, is certainly less than 0.001% among similar salts of a given metal (CuCl, CuBr, CuI).

2260 Nuclear quadrupole moments and shell structure. R. D. Hill. Phys. Rev. 76, 998(1949) Oct. 1 (Letter to the editor).

It is suggested that the spatial distortion of nuclei, and hence Q values, arises in the first order of approximation from incomplete proton and/or neutron sub-shells. The nucleon configuration of unfilled shells and the signs of the quadrupole moments which have been deduced by the author are given in tabular form for the nuclei for which Q values are known. The order of the sub-shells follows closely that given by Mayer (Phys. Rev. 75, 1969(1949)). The conclusions regarding the signs of the quadrupole moments were based on the following assumptions: (1) the shapes of nuclei are determined by the probability-density distributions $\psi\psi^*$ of the independent nucleons in the incomplete shells. (2) Completely closed shells or sub-shells (which are spherically symmetrical) do not contribute to Q. (3) In an unfilled shell having an odd number of nucleons, the "unpaired" nucleon has an m_i value equal to I, and the other nucleons distribute themselves in pairs among the remaining values of m_i (m_i is the magnetic quantum number with respect to the I field). (4) A sub-shell with only one nucleon in the state $m_i = |I|$ endows the nucleus with a negative Q value. A sub-shell with an odd number of nucleons in states $m_i = |I|, \pm 1/2, \pm 3/2, \ldots$ generally will produce a nucleus of positive Q value, the magnitude being the greater the more the nucleons are concentrated in the states of lower values of m_i.

2261 Nuclear spin 1/2 for Te^{123} and isotope shift in the tellurium spectrum. J. E. Mack and O. H. Arroe. Phys. Rev. 76, 1002(1949) Oct. 1 (Letter to the editor).

From the hollow-cathode discharge spectrum of tellurium enriched in Te^{123}, the spin of the Te^{123} nucleus has been determined to be 1/2. In addition, a comparison of the splitting of lines with that of Te^{125} results in a tentative value of $\mu_{125}/\mu_{123} = 1.208$ for the ratio of the nuclear magnetic moments of these two isotopes.

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2262 On the negative proton. Kuan-Han Sun. Phys. Rev. 76, 1266(1949) Oct. 15 (Letter to the editor).

The possible existence of negative protons, which has been speculated on by various investigators (Rosenfeld, Nuclear Forces I, 1948, p 8; Gammow, Structure of Atomic Nuclei and Nuclear Transformations, 1937, p 14), is discussed and experiments are proposed for the detection of negative proton emission. It is noted that the initial and final nuclei involved in the delayed neutron emission (or preferably the β-n decay process) are the same as those for a hypothetical process of negative proton emission. It is suggested that such particles could be detected using a cloud chamber in a magnetic field even if the probability of negative proton decay is only one in 10^7. A cyclotron producing 200-Mev deuterons would be particularly suitable for this experiment; because of the high penetrating power of deuterons, N^{17} could be produced inside the cloud chamber. It is noted that if the intensive ionizations from other radioactive products cause difficulties in the cloud chamber operation, a magnetic spectrometer with a proportional counter as detector may be used. An alternative method for detecting negative protons suggested is the observation of the annihilation radiation produced. If a pair of γ rays is produced for each annihilation, their energy would be about 10^9 ev. These could be detected by observing the showers produced by the powerful γ rays in a cloud chamber or in some device composed of lead sheets and Geiger counters. The latter arrangement would permit the location of the N^{17} (or other delayed neutron-emitter) in a container separate from the detector.

2263 On the isotopic shift and the term system of the samarium atom (SmI). Peter Brix. Z. Physik 126, 431-9(1949)(in German).

In connection with the author's work on the isotopic shift of Sm, published in Z. Physik 126, 344(1949), the shift of about 80 lines was measured, in the spectral range 5,000-7,200 A. It was established that the lines, according to the size and the sign of the corresponding shift, can be assembled into a considerable number of groups. A very satisfactory agreement is found between this fact and the grouping of spectral terms as suggested by Albertson (Phys. Rev. 47, 370(1935); 52, 644 (1937)); four new terms were added by the present author. Furthermore, it was found that the odd terms should be considered as multiplets, and the corresponding electron configurations were determined.

2264 On the value of the electric quadrupole moment of the deuteron. E. Isiguro. Progress Theoret. Phys. 3, 312(1948) July - Sept. (Letter to the editor).

Using a more refined form of the wave function than that used by Nordsieck (Phys. Rev. 58, 310(1940)), the gradient of the electric field at one nucleus in the hydrogen molecule has been recalculated for HD and for D_2. From these data the electric quadrupole moment of the deuteron has been determined as 2.79×10^{-27} cm^2 as compared with Nordsieck's value of 2.73×10^{-27} cm^2. It is believed that the result obtained is reliable to 2%.

2265 A precise determination of the proton magnetic moment in Bohr magnetons. J. H. Gardner and E. M. Purcell. Phys. Rev. 76, 1262-3(1949) Oct. 15 (Letter to the editor).

The ratio of the precession frequency of the proton to the cyclotron frequency of a free electron in the same magnetic field has been determined experimentally as a means of determining the magnetic moment of the proton in Bohr magnetons. The proton resonance absorption in mineral oil was observed by the bridge technique (Bloembergen et al, Phys. Rev. 73, 679(1948)) at a frequency of 14.24 Mc/sec. The electron resonance, at approximately 9360 Mc/sec, was obtained using an evacuated rectangular wave guide method which is described. The proton magnetic moment was determined as

$$\mu_p = (1.52100 \pm 0.00002) \times 10^{-3}(e\hbar/2mc).$$

This value is in close agreement with the one reported by Taub and Kusch (Phys. Rev. 75, 1481(1949)).

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It is also noted that the agreement may be regarded as further confirmation of the correction to the spin-moment of the electron.

2266 A precision measurement of the ratio of the nuclear g values of Li^7 and Li^6. P. Kusch and A. K. Mann. Phys. Rev. 76, 707-9(1949) Sept. 15.

The molecular beam magnetic resonance method has been used to make a precision measurement of the ratio of the nuclear g factors of Li^7 and Li^6. The central maximum of the Li^7 line and the center of the Li^6 line in the spectra of LiI and LiBr give the ratio g_7/g_6 to a precision limited only by experimental factors. The mean of eight independent determinations, under various experimental conditions, is 2.64094 ± 0.00005. This value of the ratio is compared with that calculated by use of the Fermi formula from the known ratio $\Delta\nu_7/\Delta\nu_6$. The cube of the ratio of the reduced masses of the 2s electrons in Li^6 and Li^7 is included as a factor in the calculation by analogy with the corresponding case of the hydrogens. The observed value of g_7/g_6 is greater than the value calculated by $(0.012 \pm 0.003)\%$.

2267 Some features of the level distribution in atomic nuclei. L. V. Groshev. Doklady Akad. Nauk. S.S.S.R. 65, 823-6(1949) Apr. 21 (in Russian).

Tables of nuclear energy levels are given showing excitation energies (above the ground state) of various nuclei originating from the β decay or k-capture of artificially-radioactive elements. It is seen that the lowest excitation energies are considerably higher in "even nuclei," (even mass and atomic numbers), than in "odd nuclei," (odd mass number). This regularity is tied-in with the known rule concerning the nuclear momenta, which in even nuclei are equal to zero and in odd nuclei are equal to an odd number of $\frac{1}{2} \cdot \frac{h}{2\pi}$. Since the isomer states have usually low excitation energies, the isomers should, as a rule, belong to the category of odd nuclei; statistics show that this is true.

2268 Tensor forces and the triton binding energy. Herman Feshbach and William Rarita. Phys. Rev. 75, 1384-8(1949) May 1.

The binding energy of the triton has been calculated variationally employing the Hylleraas expansion (Rarita and Present, Phys. Rev. 51, 788(1937)) for the trial wave functions, thus permitting a systematic improvement in the binding energy. The procedure used was tested by applying it to the binding energy problem of the deuteron with tensor forces. The present theory, assuming a rectangular-well shape with a range of 2.8×10^{-13} cm for all the internucleon potentials, yields a H^3 binding energy 40% - 50% of the experimental value. Various suggestions for resolving this dilemma are discussed.

2269 Zoé, French atomic pile is the first for the European continent. M. E. Nahmias. Science et Vie 75, 113-17(1949) Feb.

The French atomic pile at Châtillon is discussed and the characteristics of atomic piles located throughout the world are compared with respect to pile material, moderator, coolant, and power.

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2270 Cross section as a function of angle for the $D(d,n)He^3$ reaction for 10-Mev bombarding deuterons. K. W. Erickson, J. L. Fowler, and E. J. Stovall, Jr. AECU-546(LA-748), Aug. 29, 1949. 22p.

By counting He^3 particles with a proportional counter, the differential cross sections for the reaction $D(d,n)He^3$ have been measured at laboratory angles from 16.5° to 38.2° (39.3° to 95.0° in center of mass system) for an incident deuteron energy of 10.3 Mev. In the center of mass system, the differential cross section is 4.5×10^{-27} cm^2 at 90°, decreasing to a minimum of 2.2×10^{-27} cm^2 at about 45°, and rising steeply at lower angles. By determining the neutron yield with $Cu^{63}(n,2n)Cu^{62}$ detectors, the differential cross section at 0° has been found to be about 5 times that at 90° (center of mass). 29 references.

2271 Reactions of recoil atoms in liquids. J. M. Miller, J. W. Gryder, and R. W. Dodson. AECU-560, nd. 14p.

The reactions in liquid phase of the recoil atoms formed in the (n,γ) process are discussed in terms of a model involving energy loss by elastic collisions, dissociation of solvent molecules by impact, and eventual reaction in a liquid phase. Expressions are derived which relate the fraction of the recoil atoms ultimately found in a given molecular species to the composition and properties of the liquid. Previously published data are interpreted in terms of this model.

2272 Chemical state of radioactive phosphorus (P^{32}). F. E. Whitmore. Nature 164, 240(1949) Aug. 6 (Letter to the editor).

The chemical form of P^{32}, which has been produced by the fast neutron reaction on S^{32}, has been investigated. Pure dry sodium sulphide and thiourea samples enclosed in an argon atmosphere were irradiated in a low-energy pile at Harwell. Each sample was then opened in an inert atmosphere and treated with air-free water, and the radioactivity of the P^{32} was used as a tracer to determine the behavior of the newly formed phosphorus atoms. The results obtained indicate that a recoiling phosphorus atom loses one or more electrons and is thus in an oxidized state. In a solid medium this ion is trapped within the lattice as a positive ion, and when released by dissolving the crystal in water it is at once hydrolyzed to one of the various oxyphosphorus ions by a mechanism such as, for example, $P^+ + 2H_2O - H_2PO_2^- + 2H^+$. Investigations have also been made into the behavior of P^{32} formed from S^{32} by the irradiation of carbon disulphide and of elementary sulphur, both of which are insoluble in water. In carbon disulphide, about half the active phosphorus behaves as if it were in the elemental form. It is possible that the remainder enters into chemical combination with the target substance, and the formation of phosphorus sulphides seems likely.

2273 The determination of the charge of heavy particles emitted during the explosive disintegration of nuclei. S. O. C. Sörensen. Phil. Mag. 40, 947-55(1949) Sept.

The charges of the heavy nuclear fragments, ejected during the explosive disintegration of nuclei, can be precisely determined if the lengths of the tracks in a photographic emulsion are of the order of 1500μ or greater by the determination of the number of Δ rays per unit length containing more than a certain number of grains. The maximum observed energies of ejection of light nuclei, lithium, beryllium, and boron are of the order of 500 Mev. However, the nuclear processes which lead to the emission of heavy fragments with such great energy remain to be explained.

2274 Excitation curves for the γ-radiation from light elements bombarded with α-particles from polonium. Hilding Slätis. Arkiv Mat. Astron. Fysik 35 A. No. 31 (1948) 19p. (See also NSA 1-329).

Earlier investigations in which light elements were bombarded with polonium α particles are reviewed, particularly those which may be of interest with respect to the possibility of γ emission. The following elements were investigated: Li, Be, B, C, O, N, F, Na, Mg, Al, Si, P, S, Cl, L, Ca, and Pb.

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Emission of γ radiation was observed for Li, Be, B, N, F, Na, Mg, and Al; the intensity of the radiation as measured as a function of the energy of the α particles, except in the case of N. Also, the neutron emission from Be was studied for two α-particle energies. Tabulated values are given for the α-particle threshold values for γ emission and for the relative intensities of the γ quanta. The results obtained are discussed and compared with those of earlier investigators.

2275 On the delayed neutron emitter $_7N^{17}$. R. A. Charpie, Kuan-Han Sun, B. Jennings, and J. F. Nechaj. Phys. Rev. 76, 1255-6(1949) Oct. 15 (Letter to the editor).

An investigation was made to determine whether N^{17} can be produced by the reaction $O^{17}(n,p)N^{17}$, as expected on the basis of theoretical considerations. Neutrons of known maximum energy, produced by bombarding a thick LiF or C target with a 14-Mev 2μa external deuteron beam, were used to bombard 500 g of water containing O^{17} in its natural isotopic proportion. The delayed neutrons from this reaction were counted by means of an enriched $B^{10}F_3$ counter surrounded with 2 in. of paraffin. A half-life of 4.5 ± 1.0 sec was found, indicating the presence of N^{17}. Experiments were performed which disproved the possibility that the N^{17} was produced in the reaction $O^{18}(\gamma,p)N^{17}$. The average cross section for the (n,p) reaction on O^{17} is of the order of 10^{-26} cm^2, and hence is comparable with other such reactions.

2276 On the nuclear disintegration of lithium through fast neutrons. Ludwik Natanson. Compt. rend. 229, 588-9(1949) Sept. 19 (in French).

An Ilford C_2, lithium charged, plate was irradiated for eight hours by fast neutrons from a Be + Ra source. The reaction is $Li^6(n,\alpha)H^3$; the tracks of the α-particle and of the triton form an angle different from 180°. The energy E_α of the α-particles was determined by using the curves given by Powell and Occhialini (Nuclear physics in photographs, p. 16-17), the energy of the tritons was found from the formula $E_t = 0.262\ M^{0.425}R^{0.575}$, where E_t is the energy in Mev, M is the mass in atomic mass units, and R is the range in microns, (Blau, Phys. Rev. 75, 279(1949)). The energy E_n of the incident neutrons was obtained by using the equation of the conservation of the momentum. Finally the energy liberated at the reaction studied was determined as the difference $E_n - (E_\alpha + E_t)$. This energy was found to be equal to 4.69 ± 0.10 Mev.

2277 Proton groups from the bombardment of argon by deuterons. P. W. Davison, J. O. Buchanan, and Ernest Pollard. Phys. Rev. 76, 891-2(1949) Oct. 1.

The deuteron bombardment of both ordinary argon and argon with a 26% concentration of A^{36} has indicated the presence of 13 groups of protons. Correct assignments to isotopes can be made for 10 of these and probable assignments can be made for the others. The Q-values for the reactions are: A^{36}(dp) A^{37} 6.59, 5.06, 4.92, 4.32, 4.03, 3.13, and 1.58 and A^{40}(dp)A^{41} 3.84, 3.18, 2.63, 2.50, 1.90, 1.57, 1.04, 0.55, 0.15, −0.17. The mass difference $A^{37} - A^{36}$ is 0.99951 and $A^{41} - A^{40}$ is 1.00247. Considering that the nuclei differ by four neutrons there is surprisingly little difference in general level structure. It is noted that the first excited state of A^{37} is at an unusually high value.

2278 Electron guns for an 80-Mev synchrotron. J. M. Lafferty and H. C. Pollock. AECU-547(RL-248), Aug. 1949. 23p.

With betatrons and synchrotrons the present limitation on electron current and x-ray output at high energy is set by the difficulty of injecting a sufficient number of electrons into stable orbits when the magnetic guide field is relatively weak. The problem may be complicated by irregularities of the circular guide field, space charge effects, transient fields, the permissible limit of electron orbit oscillations, and other conditions, the importance of which varies from one machine to another. Several methods of electron injection have been tried with the 80-Mev synchrotron now in use at Schenectady. Some of the experimental injection techniques which have been tried and certain features of present

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gun construction which may be useful with other electron accelerators are mentioned in this paper. The present gun designs appear satisfactory for long-life high output operation with betatrons and synchrotrons. Progress seems possible by designing guns for electron injection at still higher voltages.

2279 The radiofrequency system of the Berkeley synchrotron. Mitchell H. Dazey, Jack V. Franck, A. C. Helmholz, Craig S. Nunan, and Jack M. Peterson. AECU-578(UCRL-406), Aug. 4, 1949. 18p.

The electron beam in the Berkeley synchrotron is accelerated to a peak energy of 335 Mev in 3 steps. The electrons are injected at a voltage of about 100 kv and are then accelerated to about 2 Mev by betatron action. Finally they are accelerated to 335 Mev by a r-f voltage applied across a gap in the beam orbit. This paper describes the design, construction, and operation of the r-f system now in operation in the Berkeley synchrotron. Material and electrical specifications for the r-f system are given. A section of the synchrotron vacuum chamber (donut) serves as a quarter wave resonator for the r-f system. The details of its construction and operation are given along with a description of the r-f circuit and oscillator.

2280 Betatron starting in high energy electron synchrotrons. J. J. Wilkins, Glasgow University. Atomic Energy Research Establishment Report No. AERE-EL/R-331, May 3, 1949. 24p.

The paper deals with the magnetic design of betatron flux bars to ensure efficient betatron starting and betatron-synchrotron transition in high energy electron synchrotrons. A brief discussion of electron trapping at transition is given, to show how a rough specification of required betatron performance may be obtained. Design equations are derived for determination of essential flux bar dimensions to meet such a specification, approximate corrections being made for skin effects in the bar laminations. The results of some detailed performance calculations on the 375-Mev Glasgow University synchrotron are given in an appendix. These calculations serve to illustrate several aspects of the betatron starting problem. 9 references.

2281 The Birmingham 1.3 Bev accelerator. T. Coor. Office of Naval Research (London Branch). June 14, 1949. 5p. (NP-999).

The synchrotron is a fixed orbit, pulse type accelerator which utilizes an r-f field for the acceleration. Inasmuch as the velocity of the particles increases through the cycle the intensity of the magnetic field and the frequency of the r-f oscillator must rise in synchronization and stay within 0.1% tolerances. The machine utilizes a circular field produced by a pulsed magnet which is constructed of a ring of "C"-shaped ½-in. iron laminations with the open part of the "C" facing outwards. The magnetic field will change from 0 to 15,000 gauss in a one-second pulse. Protons are injected into the machine at 200 kv by an electrostatic deflector when the field has a value of about 200 gauss and the r-f a frequency of 10 Mc. The beam may then be removed by a pulsed electrostatic "peeler."

2282 Electronics applied to the betatron. Theodore W. Dietze and Theodore M. Dickinson. Proc. I.R.E. 37, 1171-8(1949) Oct.

The details and theory of the various electronic betatron components are summarized under three major topics, i.e., (1) electron injection equipment, (2) electron ejection equipment, and (3) x-ray monitoring equipment. Treated as components of the electron injection equipment are the following: (a) the electron source, or gun, (b) the gun filament supply, (c) the gun accelerating voltage supply (which includes the injection pulse generator, pulse transformer and crest voltmeter, and (d) the timing pulse control circuit. The orbit-shift coils and the orbit-shift coil supply (which includes the ejection pulse generator and the peak current indicator) are treated in the section on electron ejection equipment. Finally, in considering the monitoring equipment, the two components considered are the x-ray energy monitor (megavolt-meter) and the x-ray intensity monitor (ionization chamber and associated amplifiers).

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2283 Rotating condenser for synchro-cyclotron. Martyn Foss. Carnegie Institute of Technology Synchro-Cyclotron Technical Report No. 5, Aug. 30, 1949. 13p. (NP-1101).

A design for a rotating condenser which has appropriate variation of capacity with time has been developed. A temperature compensation method is discussed. Calculation of capacity is discussed and thermal expansion of the rotor is calculated. Full scale capacity ($\mu\mu$ frequency) vs time in arbitrary units is plotted. A schematic diagram shows the condenser in a position of maximum capacity. Axial positions of condenser blades are indicated. Capacity vs position of rotor and maximum capacity vs expansion of rotor are plotted. A typical "fringing flux" flux map of a rotor blade in relation to the apparent width of stator blade is drawn. Stray capacity in a position of minimum capacity with the rotor in a 47° position in relation to the dee stator is schematically shown.

2284 Three-dimensional design of synchrotron pole-faces. C. Robinson. Proc. Phys. Soc. (London) 62A, 592-7(1949) Sept. 1.

An analytical method for the design of a synchrotron pole-face, which takes into account the cylindrical symmetry, is outlined. Relaxation methods were employed to determine the exact size and shape of the lips which correct for fringing and were also used to obtain a final check on the characteristics of the magnetic field. After a discussion of the theory of the aforementioned methods, the application to practical examples is discussed.

2285 The withdrawal of an electron beam from an electron accelerator. K. Gund and H. Reich. Z. Physik 126, 383-98(1949) (in German).

A device is described permitting the withdrawal of a dense electron beam from the betatron of the Electro-medical Laboratory of the Simens-Reiniger Plant in Erlangen. In this instrument the accelerated electrons are deflected from their orbit by a condenser. A source of serious electron losses is the edge of the inner electrode of the condenser, which is hit by the electrons before they can penetrate into the space between the electrodes; for technical reasons, this edge cannot be made sufficiently thin. The device consists of a thin (2-3 micron) aluminum foil, placed at a certain distance in front of the condenser and producing a slight scattering of the electrons; the latter, upon leaving the foil, form a narrow cone, of which the outer half enters the condenser, while the inner half, after one or more radial vibrations upon the orbit, is also caught by the condenser; in both cases the hitting of the edge of the inner electrode is avoided. Up to 70% of all electrons can thus be withdrawn from the apparatus in the shape of a narrow beam. Besides the betatron, the device can be adopted for the synchrotron and the frequency-modulated cyclotron.

2286 A simple method for the calculation of the equation of state. Maria Mayer. AECU-576 (LAMS-951), Sept. 14, 1949. 7p.

The calculation of the equation of state at high temperature is usually done by the evaluation of integrals of the type $e^{-u/kt}$, where u is the potential energy of one particle. If the potential energy is complicated, the calculations are very tedious, and considerable approximations have to be made. The simple method derived here consists of calculating the entropy of the substance at constant energy.

2287 Atomic Power. H. Etherington. AECD-2720, nd. Decl. Oct. 13, 1949. 47p.

This document, which is an article written for Mark's Handbook, contains the following sections: Atomic Energy (units in nuclear physics, equivalence of mass and energy, structure of the atom, nuclear stability, radioactivity, nuclear fuels); Effects of Irradiation (absorption of gamma photons, ionization effects, damage to materials, health physics); Reactor Design (critical size, control, design problems); Economics and Future Developments (supplies of uranium and thorium, estimated cost of atomic power, future of atomic power).

PHYSICS (continued)

2288 Abstracts of papers presented at the eighty-first meeting of the American Astronomical Society. Astron., J. 54, 180-97(1949) Sept.

Included in the abstracts of papers presented at the eighty-first meeting of the American Astronomical Society, which was held at Ottawa, Canada, June 19-23, 1949, are the following pertaining to nuclear physics: Proton-proton reactions in red dwarf stars, Lawrence H. Aller; Forbidden lines of ionized nitrogen in the planetary nebulae, Lawrence H. Aller and Marvin L. White; Wave functions with I.B.M. equipment, Louis C. Green; Intensities of isotopic carbon bands in the λ6191 sequence of the Swan system for some R-type spectra, Andrew McKellar; Polarization of light by interstellar grains, Lyman Spitzer, Jr., and Evry Schatzman.

2289 Atomic structure and energy. J. R. Dunning. Am. Scientist 37, 505-28(1949) Oct.

The following principal topics are treated in a non-technical fashion: (1) atoms and isotopes, (2) nuclear energy, (3) nuclear research, (4) transmutation and radioisotopes, (5) energetics of nuclear processes, and (6) mesons and nuclear forces.

2290 A mechanical velocity selector for neutrons. Ingram Block. AECD-2702, Nov. 17, 1944. Decl. Sept. 26, 1949. 8p.

A mechanical velocity selector for neutrons is proposed as follows. A long cylinder cut along its entire length with helical slots could, if rotated about its axis, act as a velocity selector for neutrons impinging on its end. The only neutrons which could proceed directly through the slots would be those whose speeds lay in a certain narrow range and whose direction of motion lay in a certain solid angle. The mathematical theory leading to the number of neutrons getting through 1 unit area 1 second within velocity limits, construction and dimensions, and comparisons with existing velocity selectors are given.

2291 Operating instructions for the radiation alarm, model 2. Victoreen Instrument Co. AECD-2723, nd. Decl. Oct. 11, 1949. 3p.

This is not an abstract; the document is reproduced below in its entirety.

The Radiation Alarm, Model 2, consists of an ionization chamber of negligible leakage, an electrometer tube built into the same housing, a direct-coupled amplifier connected to the electrometer tube through a long cable, an indicating meter, a timer, and the alarm circuits. The ionization chamber is charged to approximately 25 volts and maintains this charge until discharged by radiation. One-tenth roentgen reduces the charge on the chamber by 13 volts.

When the chamber is discharged by this amount, relays are actuated which light a red warning light on the front panel, sound a buzzer, and close a pair of contacts which may be connected to an external alarm. After an interval of about fifteen seconds these relays open, and the chamber automatically recharges. In the event that insufficient radiation impinges on the chamber to discharge it during an eight-hour period, a timer in the instrument will recharge the chamber automatically at the expiration of this time. A dial on the panel of the instrument shows the expired time, and may be adjusted to recharge the chamber after any desired interval up to eight hours. The alarm sounds for forty-five seconds when the chamber is being recharged by the timer.

The instrument was correctly adjusted when shipped, and the only adjustment necessary should be to set the meter to zero after charging the chamber. In the event the adjustment controls should be displaced, however, the procedure for adjusting the instrument is as follows:

Open the door of the instrument and remove the two small screws on the right-hand edge of the panel. This permits the front panel to be swung out. The instrument should be set well back on the bench before opening this door; it is unbalanced in this position and may tilt forward.

After the instrument is turned on and allowed to warm up, the charge should be removed from the chamber and the chamber recharged by the manual charging switch on the front panel. Inside the door, on the right-hand edge of the chassis, will be found two adjusting knobs, separated by a switch

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labeled "Calibrate"; this switch must always be in the "Off" position except when the instrument is being adjusted. The upper knob is a sensitivity control and the lower knob is a zero-set.

The sensitivity control should first be turned all the way to the left and the zero-set knob turned until the meter on the front panel reads 95 or thereabouts. This adjustment is not critical.

The sensitivity control should then be turned about three-quarters of the way to the right, and the meter set at zero by means of the "Meter Set" knob on the front panel. Then the "Calibrate" switch is thrown to "On." If the sensitivity control was correctly set, the meter should now read 78. If it does not read 78, set the needle to 78 by means of the "Meter Set" and throw the "Calibrate" switch to "Off." The needle will then no longer read zero, and should be set to zero by means of the sensitivity control. When this is done, again throw the "Calibrate" switch to "On" and check to see that the needle now reads 78. If it does not yet read this figure, set the needle to 78 by means of the "Meter Set," and proceed as before. One or two adjustments will generally be sufficient. Make sure the "Calibrate" switch is turned to the "Off" position before closing the front panel.

When the instrument is first turned on, the chamber will charge to a higher voltage than it reaches on subsequent recharges; and the meter will have to be reset after the chamber is run down the first time. However, the first run is quite as accurate as subsequent runs, and no difficulty need be anticipated from this source other than the necessity of resetting the zero.

2292 Calibration of a slow neutron pocket dosemeter. Ben Kalmon. AECU-553(ORNL-400), nd. 9p.

A boron lined, thermal neutron sensitive pocket dosimeter manufactured by the Kelly-Koett Manufacturing Co. has been tested for response to Ra-γ-radiation, Po-Be fast neutrons, and thermal neutrons from the Clinton Pile. A capacitor is inserted in parallel with the chamber in order to decrease the γ response. Gamma-ray exposure to approximately 500 mr indicated less than 10 mr. On exposure to 7.35×10^6 fast neutrons/cm^2, there was no significant response. Its sensitivity to thermal neutrons was found to be such that the maximum daily permissable dose (1600 thermal neutrons/cm^2/sec) indicates approximately 120 mr. With the elimination of 2 minor design faults, the meter is considered to be satisfactory as a personnel monitoring instrument for thermal neutrons. A calibration curve is included.

2293 A high resolution scale-of-four. Val Fitch. AECU-554(CUD-35), Aug. 25, 1949. 10p.

A high resolution scale-of-four has been developed for use in conjunction with the nuclear particle detection devices in applications where the counting rate is unusually high. Specifically, it is intended to precede the commercially available medium resolution scaling circuits and so decrease the resolving time of the counting system. The circuit will function reliably on continuously recurring pulses separated by less than 0.1 μ sec. It will resolve 2 pulses (occurring at a moderate repetition rate) which are spaced at 0.04 μ sec. A 5-volt input signal is sufficient to actuate the device. Chassis and circuit diagrams are included.

2294 A new technique for the measurement of neutron energy spectra. George Robert Keepin, Jr. AECU-563(LAMS-924), July 18, 1949. 84p.

An approach to the problem of fast neutron energy measurement is offered through the use of special photographic emulsions impregnated with Li^6. The method employs the nuclear reaction, $Li^6 + n \rightarrow Li^{7*} \rightarrow He^4 + H^3$ which takes place within an impregnated emulsion. Photomicrographs of single Li^6 disintegrations produced by neutrons of various energies are included. Following a brief historical resumé of the photographic method in nuclear physics generally, experimental problems peculiar to the new Li^6 technique are discussed. The results of research on optimum processing and measuring techniques are given. Pending the determination of correction functions, a technique is evolved which extends the photographic method to the energy region outside present limits set by recoil-

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proton methods. In addition, the Li^6 technique affords the advantages of: (1) no collimation requirements, and (2) minimized perturbation of the distribution being studied. 32 references.

2295 Absolute beta counting using end-window Geiger-Müller counters and experimental data on beta-particle scattering effects. Lloyd R. Zumwalt. AECU-567(MonC-397), Sept. 14, 1949. 120p. (See also MDDC-1346).

A study of absolute β counting using conventional end-window counter tubes is presented. The work was begun at a time when β-ray standards were not available from the Bureau of Standards, and the report describes experiments in which standards were prepared and then used to calibrate G-M tubes for absolute counting. Particularly in such determinations, the question has arisen whether the calibration applies with accuracy to β emitters which have a maximum β-particle energy considerably different from that of the standard. The study shows that in the absence of absorption and scattering of β particles the efficiency of the counter for counting is determined primarily by the geometrical relationship of the source of particles to the sensitive volume of the tube. The variation with energy of the probability of β particles causing a discharge in the tube is considered. In the ideal case, the number of particles counted is equal to the number of particles emitted by the source times G, the geometry factor. In practice the number of particles counted may be expressed by the following equation: $(c/m) = (d/m)G\, f_W\, f_A\, f_B\, f_H\, f_S$ in which (c/m) is the counts per minute detected by the counter; (d/m) is the actual number of disintegrations per minute in the sample; G is the solid angle geometry of the source and the counter; f_W is the factor for the effect of the absorption of the β particles by the window and the air between the source and the window; f_A is the factor for the effect of air in scattering β particles into the counter; f_B is the factor for the increase in counting rate due to backscattering from the sample mounting; f_H is the factor for scattering effect of the source support structure and the housing; and f_S is the factor for the effect of the mass of the source in causing both scattering and absorption of β particles (self-absorption and scattering). In this study each of the above factors was evaluated singly. The first part of the report gives the description of the experimental techniques and arrangements used, the results of the evaluation of the several absorption and scattering factors, and the results of the determinations of G using β emitters of known disintegration rates having maximum energies ranging from 0.3 to 2.3 Mev. These are compared with the solid angle geometries determined from the dimensions of the experiment. Also, results are given on the intercomparison of secondary radium E (Bi^{210}) standards with the National Bureau of Standards sources. The second part of the report gives results of a body of backscattering and forescattering data as a function of the energy of radiation and the atomic number of backing materials. The angular distribution is discussed as well as a study of the hardness of the backscattered radiation. The forescattering data are treated as a function of the position of the absorber and the source. Appendix A gives the theory of the probability of counting β particles in end-window counter tubes. Appendix B gives formulas for calculating the solid angle subtended by a disk at a point. Appendix C gives the results of calculations relative to the theory of multiple scattering of electrons developed by Bethe et al (Proc. Am. Phil. Soc. 78, 573(1938)). This includes a comparison of a theoretically calculated total length of electron path with experimentally determined electron range as a function of energy. Extensive references included.

2296 Aluminum window glass counter. Violet V. Kissee. AECU-570(LAMS-918), July 11, 1949. 11p.

This counter was designed to count low energy betas over a wide area. Therefore, it has a large, thin, window with no grid. The envelope is of 3-1/4 in. I.D. glass 4 in. high. In the top center is an opening for sealing in the central wire. On one side is an opening for sealing in the cathode lead. On the opposite side is an opening for filling. This can have a stop-cock or a tube which can be sealed with wax. The bottom of the envelope is flanged and ground. A diagram is shown. The cathode is a strip of copper 2-1/2 in. high whose length is the circumference of the envelope. Detailed directions for assembling the counter are given.

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2297 Adapter for visual monitoring with portable Geiger-Müller equipment. Howard T. Blinn, Russell F. Cowing, and Charles K. Spalding. Science 110, 382-3(1949) Oct. 7.

The application of a neon-filled strobotron (SN4) tube as a visual means of continuous monitoring of areas in which radioactive materials are used has proved to be very convenient. A circuit developed for this purpose is shown. Using a β-ray Geiger-Müller counter having a glass wall of 30 mg/cm^2, 3 μc of P^{32}, I^{131} and Ra salts was found to produce a flash rate of about twice background at a source distance of 25 cm.

2298 Analysis of delayed coincidence counting experiments. Daniel Binder. Phys. Rev. 76, 856-58(1949) Sept. 15 (Letter to the editor).

The delayed coincidence counting method is analyzed and expressions are obtained which take into account the random delays introduced in the counter.

2299 An apparatus for increasing the accuracy of Geiger counter equipment. The development of probe unit type 1014. C. D. Florida. Atomic Energy Research Establishment Report No. AERE-G/R-276, Jan. 11, 1949. 20p.

In counting experiments with G-M counters there are certain disadvantages which are inherent to the instrument itself. These include (1) spurious pulses, (2) temperature effects, and (3) difficulty of applying dead-time corrections. A new probe unit has been designed which reduces the potential (quenching phenomenon) across the G-M counter by 200-300 volts to below the threshold voltage for counting disintegrations, and thus eliminates spurious pulses. The duration of quenching can be varied but is accurately determinable, consequently removing the inaccuracy inherent in the normal estimation of dead-time correction. The design, operation, and testing of a preliminary probe circuit and of an improved circuit are described. Detailed calculations of the grid potential for the first circuit and of resistor chain values for the second circuit are given in appendixes.

2300 Build your own Geiger counter. Walter B. Ford. Radio Television News 42, 34-6, 72-4(1949) July.

Circuit diagrams and assembly instructions are given for two types of Geiger-Müller counters, i.e., a portable, battery-operated model and a laboratory counter.

2301 CO_2 counter techniques for C^{14} measurement. G. L. Brownell and H. S. Lockhart. MIT Technical Report No. 30. Sept. 12, 1949. (NP-1079).

The CO_2 counter technique provides a very sensitive method for C^{14} detection and measurement. In this report, the problems encountered in the use of CO_2 counters are discussed in sufficient detail to be of use to laboratories planning to use this method. Sections are devoted to each of the operations necessary for preparing the sample and determining the activity. The theory of CO_2 counters has been presented in other reports and is mentioned only briefly here. 13 references.

2302 The detection of Ca^{45}, I^{131}, P^{32}, and Zn^{65} by photographic film. Daniel Steinberg and A. K. Solomon. Rev. Sci. Instruments 20, 655-9(1949) Sept.

The density response of photographic emulsions to the radiations of Ca^{45}, I^{131}, P^{32} and Zn^{65} has been determined. Characteristic curves for all four isotopes against Eastman "no-screen" x-ray film and Eastman type M stripping film are presented, together with certain additional studies on Eastman NTB stripping film and Eastman type K x-ray film. The relative photographic effectiveness of the isotopes examined increases in the order: Zn^{65}, P^{32}, I^{131}, Ca^{45}, C^{14}. Applications of the data to quantitative radioautography are discussed.

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2303 Determination of energy of single alpha-particles from change in conductivity of cadmium sulphide crystals. H. Kallmann and R. Warminsky. Research 2, 389-92(1949) Aug.

Previous work by Broser et al (Research 2, 87(1949)), on the conductivity of cadmium sulphide crystals, has been continued and the behavior of weakly activated crystals, excited by single α particles, has been investigated in detail. It was found that the current pulses in these crystals are proportional to the energy of the absorbed particles. This property, as well as the short decay period of the pulses, suggests the suitability of such crystals for quantitative measurements. Crystals of this type have several advantages over the ionization chamber; in particular, the arrangement used is much simpler.

2304 The electron optical properties of the focal isolation β-ray spectrometer. D. K. Butt. Proc. Phys. Soc. (London) 62 B, 551-64(1949) Sept. 1.

An attempt is made to show theoretically how the performance of a lens spectrometer depends upon the degree of spherical aberration present in the lens. In particular, curves of resolving power and transmission are plotted against radius and area of the central lens annulus, for source and counter window on the axis and of equal diameter. The resolving properties of a circular source and counter window placed at equal distances off the axis are determined and the arrangement is found to be impracticable. Lastly, an investigation is made into the resolving properties of a line source placed at right angles to the axis of the spectrometer, the image of which is focused into a slit-shaped window in a counter. The arrangement is shown to be advantageous particularly when long solenoids are employed, as in high energy β spectroscopy.

2305 Geiger tube quenching circuit for a negative high voltage supply. Richard John Watts. Rev. Sci. Instruments 20, 699(1949) Sept. (Laboratory and shop note).

A modified Neher-Harper circuit (with circuit constants given) is shown which can be used to assist the quenching action of a Geiger-Müller tube. The following modifications were introduced in the conventional Neher-Harper circuit: (1) the use of a negative high voltage supply, and (2) the elimination of the necessity for a high voltage across receiving type tubes not designed for this purpose.

2306 On Geiger-Müller counters with external cathodes. Daniel Blanc and Maurice Schérer. Compt. rend. 228, 2018-20(1949) June 27 (in French).

Maze (J. physique 7, 164(1946)) has described a counter in which the outer surface of the glass wall is partly covered with graphite; this graphite coating is grounded and forms the cathode of the instrument. The present author found that in this shape the counter has no characteristic effective length: the performance is not proportional to the length of the cathode, and it is not zero when that length is zero. Since the disturbing cause must reside in the end parts of the inner wire, the author coated the end parts of the glass wall with graphite and maintained these coatings at the potential of the inner wire; the cathode-forming graphite occupies the intermediate part of the wall, and is separated from the end parts by paraffin-coated zones. The defects mentioned above were removed by this modification of the device.

2307 Improvements in the making of special photographic emulsions for nuclear physics. Pierre Demers. Science 110, 380(1949) Oct. 7.

An emulsion-making machine is described which permits the reproduction of the concentrated, very fine-grained emulsion formula 2 previously described by the author (Can. J. Research 25A, 233 (1947)). It was found that the emulsion was not easily duplicated unless careful attention was paid to the mechanical and stoichiometric conditions during the mixing operation, and to the temperature of the wash water and the type of gelatin used. A diagram of the instrument, which satisfactorily produces the special emulsion, is shown.

PHYSICS (continued)

2308 Integrating crystal detectors for high energy photons and particles. R. S. Alger. MIT Technical Report No. XV. Jan. 1949. 32p. (NP-900).

Three of the alkali halides, LiF, KBr, and NaCl were examined as integrating detectors for high energy photons and particles. Dosage measurements were based on the number of color centers formed in single crystals under x-ray and cathode ray bombardment. Exposures of 20 to 10^4r (30 kv x-rays) were measured photoelectrically and 10^5 to 10^7 r (3 Mev x-rays and cathode rays) were measured optically. The crystals have advantages in measurements where wide range, high absorption, small size, and simplicity are desirable; however, their use is restricted by the length of the bleaching period required between exposures.

2309 Investigation of soft radiation by proportional counters. V. Use as a detector of ultra-violet quanta and analysis of the gas multiplication process. S. C. Curran, A. L. Cockroft, and J. Angus. Phil. Mag. 40, 929-37(1949) Sept. (See also NSA 2-967; 2-968).

The quantitative detection of single slow electrons liberated by light at the cathode of a proportional counter has been observed and good plateaux obtained. The distribution in amplitude of the output pulses has been measured and the shape of this distribution has been shown to correspond rather closely with the curve:

$$x^{1/2} \exp(-x).$$

The variation introduced by the gas gain alone has been calculated for various fixed amounts of ionization and compared with the experimental observations on homogeneous radiations. By this means the fluctuations in the number of ion pairs released in the gas by electrons totally absorbed in the counter has been deduced. The total fluctuation for a mixture of equal quantities of argon and methane, is approximately

$$\sigma_p^2/\bar{P}^2 = (\alpha + \beta)/\bar{N}$$

where $\alpha = 2/3(0.681)$ and $\beta = 2/3$ for $E_i = 32$ ev; $\bar{P}$ is the average pulse size, σ_p is the root mean square deviation of this size, E_i is the average energy lost per collision and $\bar{N}$ is the average number of electrons. It appears that the total variation can thus be split into its two main components. This variation is smaller than that given by Snyder (Phys. Rev. 72, 181a(1947)) and may indicate a need for a modified form of the theory.

2310 Investigation of soft radiations by proportional counters. VI. The beta spectrum of sulphur 35. A. L. Cockroft and G. M. Insch. Phil. Mag. 40, 1014-18(1949) Oct.

The β-spectrum of S^{35} was analyzed by means of a large proportional counter (Phil. Mag. 40, 522(1949)). The spectrum shows a departure from the Fermi distribution for an allowed transition in the region of low energies and has a maximum intensity at ~16.5 kev.

2311 Ionization chambers and counters: experimental techniques. Bruno B. Rossi and Hans H. Staub. New York, McGraw-Hill, 1949. 243p. NNES Div. V, Vol. 2.

The experimental methods of nuclear physics which are employed in using particle and radiation detectors are considered and the following topics are treated: (1) the theory and behavior of free electrons and ions in gases; (2) the operation of ionization chambers with constant ionization; (3) the operation of ionization chambers with variable ionization; (4) gas multiplication; (5) β, γ, and x-ray detectors; (6) α detectors; (7) detectors for neutron recoils; (8) detectors of (n,α) and (n,p) reactions; and (9) fission detectors.

PHYSICS (continued)

2312 A new method of analysis of the beta-ray spectrum. Mitsuo Sakai and Seitaro Nakamura. Phys. Rev. 76, 967-9(1949) Oct. 1.

A new method of analysis is developed for taking into account the β-ray spectrum as a whole. The emphasis is placed on the point of maximum intensity of the spectrum, rather than on the lower or the upper end. The following tentative conclusions are made: (1) Experimental spectra now available show some deviations from Fermi theory which should be considered as a standard reference. (2) These deviations are found to manifest a certain tendency without any distinction between the allowed and the forbidden transitions. (3) These deviations tend to increase with the atomic number of the elements and are hardly related to the upper end of the spectrum. Hence, the forbidden correction factors are not likely to explain these deviations. A possible classification is discussed in which the Coulomb effect is considered.

2313 A new method of study of disintegrations producing two ionizing particles in photographic plates. Raymond Chastel. Compt. rend. 228, 1725-7(1949) May 30 (in French).

In nuclear disintegrations in photo-emulsions, which result in two heavy ionizing particles whose tracks have opposite directions, it is impossible to locate the point of the disintegrations. A method for the determination of this point, and for the measurement of the individual ranges and energies of the two particles, is based on the following consideration. If a disintegration takes place at the surface of the emulsion adjoining the glass, the track in the emulsion will belong to only one of the two particles; therefore, a statistics of tracks reaching the glass will show two minimum lengths corresponding to the ranges of the disintegration products. The method was applied to the reaction $Li^6(n, H^3)He^4$. Only one minimum, viz. that corresponding to the α particle, was used; the range of H^3 was inferred from the difference. The results agree with those obtained by the following authors, working with different methods: Faraggi (Compt. rend 227, 527(1948)) using a procedure based on the fact that during the fading process the disintegration point appears as a blank spot on the common track; Bøggild et al (Phys. Rev. 75, 782(1949)) using certain known values for the range of α particles and protons in the emulsion. In the present author's opinion, the principle of his method could be applied to other instruments, such as the ionization chamber with a proportional amplifier; for example, by measuring the minimum amplitude of pulses in a BF_3 counter, the range of Li nuclei from $B^{10}(n,\alpha)Li^7$ could be determined.

2314 The photographic plate as an instrument in nuclear research autoradiography and radiation monitoring. J. H. Webb. Science 110, 355-6(1949) Oct. 7.

The applications of the sensitive, nuclear-emulsion photographic plate are reviewed. In particular the applications of this technique to nuclear physics, to monitoring for the detection of health hazards, and to autoradiography are considered.

2315 Range distribution of the α-particles of uranium in the photographic emulsion. M. Bogaardt and M. Bottema. Physica 15, 358-60(1949) May.

As a preliminary to photographic emulsion investigations, data was obtained on the statistical fluctuations of the track-lengths of mono-energetic particles in the emulsion. The tracks from the decay of pure natural uranium were used, and the experimental distribution and the Gaussian curve with the same standard deviation are shown. From these it is concluded that a Gaussian curve with the standard deviation calculated for the experimental points does not give a satisfactory fit. However, since a half-value considerably less than 10% can be obtained with an Ilford E_1 emulsion, this emulsion has a greater resolving power than the older type (Tsiang et al, Compt. rend. 223, 571 (1946)).

PHYSICS (continued)

2316 High energy photons from proton-nucleon collisions. R. Bjorklund, W. E. Crandall, B. J. Moyer, and H. F. York. AECU-574(UCRL-439), Aug. 15, 1949. 22p.

In view of the success of the 184-in. synchro-cyclotron in producing the π mesons observed in high-altitude cosmic ray observations, a search has been made for possible evidence bearing on the origin of the soft component of cosmic rays in the collisions of the 340-Mev protons with matter. Evidence is presented for the production of high-energy photons in the collision of protons of energies over 175-Mev with the cyclotron target. Results are considered as being preliminary and experimental details are held to a minimum. The yield and the spectrum seem to exclude a bremsstrahlung origin, and a Doppler shift effect excludes a nuclear origin. The observations are consistent with a source associated with proton-nucleon impacts (as distinguished from proton-nucleus collisions). For data on the photon yields versus proton energies, 1/2-in. carbon targets were used. For a more careful determination of absolute yield data, a 2-in. beryllium target was used.

2317 Experimental study of the Compton effect at 1.2 Mev. Robert Hofstadter and John A. McIntyre. Phys. Rev. 76, 1269-70(1949) Oct. 15 (Letter to the editor).

The recent development of scintillation counters for counting γ rays has made possible a more accurate experimental investigation of the angular scattering in the Compton effect. A 20-mc Co^{60} rod served as a source and the detector used was a block of stilbene 1/2 in. $\times$ 1/2 in. $\times$ 1 in. The crystals as well as the 1P21 photomultipliers were carefully selected and the latter were cooled to dry ice temperature in operation. A curve is given which indicates the number of coincidences between the recoil electron (measured by the scatterer) and the scattered photon (measured by the detector) as a function of the angular position of the detector. The experimental data are compared with the theoretical curves and it is noted that the Klein-Nishina curve fits the data much better than either the Dirac-Gordon or Compton curves.

2318 On the angular distribution of D-D reaction products. Yoshihiro Nakano. Phys. Rev. 76, 981-2(1949) Oct. 1 (Letter to the editor).

Using the same notation as Konopinski and Teller (Phys. Rev. 73, 822(1948)), their previous work has been extended taking the d waves into account in order to explain the results of Blair et al (Phys. Rev. 74, 1599(1948)). Values for A and B in the expression for the angular distribution of the d-d reaction products, i.e., $I(\theta) = (1 + B\cos^2\theta)$, are obtained which give satisfactory agreement with the experimental data. The nuclear penetrabilities were evaluated numerically by means of Bethe's formula (Revs. Modern Phys. 9, 178 (1937)), assuming the value 7×10^{-13} cm for the distance of closest approach.

2319 Penetration and diffusion of x-rays through thick barriers. II. The asymptotic behavior when pair production is important. U. Fano. Phys. Rev. 76, 739-42 (1949) Sept. 15.

The methods of a previous paper (Phys. Rev. 76, 538(1949)) are modified to cover the high energy x-rays which are strongly absorbed by pair production. The variation of intensity with depth of penetration is then expected to follow a law of the type $x^{-5/6} \exp(-\mu_m x + bx^{1/3})$.

2320 S-wave proton-proton scattering from 0.2 to 40 Mev for the Yukawa and Gauss error potentials. R. D. Hatcher, G. B. Arfken, and G. Breit. Phys. Rev. 75, 1389-98(1949) May 1.

Tables of the phase shift expected for the S-wave in proton-proton scattering are presented. The energy range covered is from 0.2 - 40 Mev. The accuracy obtainable by this means is stated in the text and is believed to be sufficient for most applications. For energies below 5 Mev, use is made of the function f which varies nearly linearly with energy. Representations of f in terms of depth and range of the potential wells are studied and some questions arising in comparing potentials with each other and with experimental results are briefly discussed.

PHYSICS (continued)

2321 The specific alpha radioactivity and half-life of plutonium isotope of mass 239. Edgar F. Westrum, Jr., J. C. Hindman, and R. Greenlee. AECD-2708, nd. Decl. Sept. 19, 1949. 18p.

Several series of measurements of the specific α activity of Pu^{239} are described. Plates for radiometric assay have been made by weighing samples of metal and of pure compounds from highly purified Pu stocks. The specific activity of Pu^{239} is reported to be 136,060 ± 400 disintegrations/min/μg. This corresponds to a half-life of 24,400 ± 70 yr. 19 references.

2322 The beta spectra of Cl^{38}. Lawrence M. Langer. AECD-2722, nd. Decl. Oct. 11, 1949. 15p. Proposed for publication in Phys. Rev.

The β spectra of the 38-min activity of Cl^{38} has been studied in a magnetic lens spectrometer. The momentum distribution was resolved into three groups with the following end points and branching ratios: 4.18 ± .04 Mev, 53.4%; 2.77 ± .05 Mev, 15.8%; 1.11 ± .01 Mev, 30.8%. The highest energy group is interpreted to have a shape characteristic of a once forbidden transition involving a spin change of 2 units and a change of parity. Interpretation of Fermi plots of the data is discussed. 9 references.

2323 The beta spectrum of Tl^{204}, magic numbers, and neutron pairing. D. Saxon and J. Richards. AECU-544(UAC-138), nd. 5p.

The β spectrum of the 3 yr Tl^{204} is said to be of special interest because the nuclei involved lie close to the magic numbers 82 for protons and 126 for neutrons (M. G. Mayer, Phys. Rev. 74, 235(1948); E. Feenberg, Phys. Rev. 75, 320(1949)). Thallium nitrate was irradiated in the Hanford pile; the particular sample used had been cooling for over 2 yr so that all short lived activities had disappeared. As a further precaution, a chemical purification was performed involving the conversion to the chloride followed by a final extraction. The 180° spectrometer was used at 2% resolution in H_ρ. The relativistic Fermi function Kurie plot using the daughter Pb, Z = 82, is depicted. Kurie plots, one corrected for the 2% spectrometer resolution (G. E. Owen and H. Primakoff, Phys. Rev. 74, 1406(1948)) and the other with the $\sqrt{G}$ factor which for G−T selection rules goes with first forbidden, $\Delta l = 2$, and parity change. Both corrections are shown on a third plot where the linear range extends down to ~350 kev. Following interpretation, the final value using the average from before and after correction is given as 783 ± 10 kev.

2324 Tables of K-shell internal conversion coefficients. M. E. Rose, G. Goertzel, B. Spinrad, J. Harr, and P. Strong. AECU-550(CF-49-9-141), nd. 21p.

The coefficients were computed on the Automatic Sequence Relay Calculator (Mark I) from the relativistic formulas (using Dirac wave functions) for Z = 40, 54, 64, 72, 78, 83, 88, 92, and 96 and k (γ-ray energy/mc^2) = 0.3 (The values at k = 0.3 were obtained for the first five Z values only), 0.5, 1.0, 1.8, 3.0, and 5.0 for electric (α_l) and magnetic multipoles (β_l) of order 2^l with l = 1, 2, 3, 4, and 5. From these 500 points, which were obtained to 4 significant figures, an additional 2560 points were obtained for intermediate values of Z and k by graphical interpolation. These interpolated points are accurate to 1% or better. The spacing of the interpolated points was chosen so that any additional interpolation can be made linearly by interpolating log of the internal conversion coefficient versus Z and versus log k.

2325 A revaluation of the gamma-radiations from Co^{60} and Zn^{65}. Erling N. Jensen, L. Jackson Laslett, and William W. Pratt. AECU-559, nd. 3p.

Work on a definitive check of the presumed proportionality between the focussed momenta and the currents in an iron-free magnetic lens spectrometer is reported. The check was made in conjunction with a remeasurement of photoelectric conversion lines from Co^{60}. This work has confirmed the linearity of the instrument but has led to a revised value of the spectrometer constant which is almost 1% greater than that found in earlier work.

PHYSICS (continued)

2326 Absence of angular correlation between β- and γ-rays in allowed β-transitions. M. A. Grace, R. A. Allen, and H. Halban. Nature 164, 538-9(1949) Sept. 24 (Letter to the editor).

An experimental investigation has been made which demonstrates the expected lack of angular correlation between the direction of emission of the β and γ rays from the decay of an excited nucleus following an allowed β transition. The following results were obtained for $I(\pi)/I(\pi/2)$, were $I(\theta)$ is the coincidence-rate with an angular separation θ:

Na^{24}	0.99 ± 0.019
Co^{60}	1.00 ± 0.025

The influence of correlation between the two γ rays would be to make the above ratio 1.003 for Na^{24} and 1.01 for Co^{60}, the difference being due to the lower detectability of the β-rays from Co^{60}. These data were obtained using two photomultipliers as detectors and a source mounted on a turntable. This experimental confirmation of the absence of correlation is of interest for both theoretical and practical reasons. The direct evidence that an allowed β transition is not associated with a change in orbital momentum could aid in identifying such allowed transitions. The lack of correlation is also of interest in taking data on β-γ coincidences. It is noted that Co^{60} and Na^{24} were used in these experiments because the absence of an angular correlation is only a proof that there is no change of orbital momentum in the β-transition when it is already established that the excited nucleus formed in the β-transition has an angular momentum different from zero; such is the case for the aformentioned isotopes.

2327 The angular distribution of γ-radiation from light nuclei. I. Experimental. S. Devons and M. G. N. Hine. Proc. Roy. Soc. (London) 199 A, 56-73(1949) Oct. 7.

The experimental procedure used in studying the angular distribution of γ radiation produced by the proton bombardment of some light nuclei is described. Results are given for the radiation following proton capture by the nuclei Li^7, Be^9, C^{12}, C^{13}, and for the radiation from the residual O^{16*} nucleus produced in the reaction $F^{19}(p,\alpha)O^{16*}$. Proton energies between 300 and 1,000 kev were available. The distribution of the radiation from Li^7 was investigated over the whole range of energies; in the other cases the distribution was measured at energies corresponding to resonance maxima for the processes. The main results are:

reaction	proton energy (kev)	angular distribution
$Li^7(p,\gamma)Be^8$	440	$1 + 0.05 \cos\theta$
$Be^9(p,\gamma)B^{10}$	960	$1 + 0.09 \sin^2\theta$
$C^{12}(p,\gamma)N^{13}$	450	isotropic
$C^{13}(p,\gamma)N^{14}$	550	isotropic
$F^{19}(p,\alpha)O^{16*}$	330, 470 and 670	isotropic
	590	$1 + 0.2 \cos^2\theta$
	870	$1 + 0.1 \cos^2\theta$

2328 The angular distribution of γ-radiation from light nuclei. II. Theoretical. S. Devons and M. G. N. Hine. Proc. Roy. Soc. (London) 199 A, 73-88(1949) Oct. 7.

A general discussion is given of the factors which determine the angular correlation between incident particles and emitted radiation, in the case of particle capture by nuclei of light atoms. The results are applied to the cases $Be^9(p,\gamma)$; $C^{12}(p,\gamma)$; $C^{13}(p,\gamma)$; $F^{19}(p,\alpha)O^{16*}$, $O^{16*} \rightarrow O + \gamma$; and in some detail to $Li^7(p,\gamma)$. In the case of Li^7, the variation of the angular distribution of the γ radiation with proton energy has been studied, and the results compared with a detailed theoretical interpretation, based

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on the Breit-Wigner dispersion formula applied to more than one level of the compound nucleus. The comparison provides excellent support for the validity of the dispersion formula, and the conditions are very favorable for such a check.

2329 Cloud-chamber study of high energy positrons from Na^{22}. Kennard H. Morganstern and Karl P. W. Wolf. Phys. Rev. 76, 1261-2(1949) Oct. 15 (Letter to the editor).

A 25-cm diameter cloud chamber filled with a hydrogen-alcohol mixture has been used to investigate the energy and frequency of the higher energy positrons from Na^{22}. A weak source of Na^{22} was placed on a thin Al backing and suspended in the chamber along with a glass baffle which was used to help distinguish between the positron tracks and those of electrons ejected by γ rays at the source holder. The chamber was in a pulsed magnetic field of 700 gauss. Sixty-nine tracks were positively identified as high energy positron tracks; the histogram of these tracks is shown and it is noted that the end point agrees satisfactorily with what would be expected in a transition of the Na^{22} directly to the ground state of Ne^{22}. An upper limit to the probability of positron emission has been estimated as approximately one in 26,000.

2330 Confirmation of Cl^{39} activity. R. N. H. Haslam, L. Katz, H. E. Johns, and H. J. Moody. Phys. Rev. 76, 704(1949) Sept. 1 (Letter to the editor).

In the course of irradiating pure argon at a pressure of 10 atm with 23-Mev β rays a new activity with a half-life of 55 ± 0.2 min was produced. This has been identified as a β^--activity and ascribed to the isotope Cl^{39} produced in the reaction $A^{40}(\gamma,p)Cl^{39}$. Aluminum absorption curves show that if only one β^- is present in the Cl^{39} decay, it has an energy of 2.5 Mev. A more exact analysis is in progress to determine the disintegration scheme of this isotope. The results obtained also indicate that the previously reported 4-min activity (G. T. Seaborg and I. Perlman, Revs. Modern Phys. 20, 585(1948); Pool, Cork, and Thornton, Phys. Rev. 52, 239(1937)), which has been attributed to A^{39}, does not occur.

2331 Determination of the α energy of U^{235} and of the half-life period of U^{234}. E. Baldinger and P. Huber. Helv. Phys. Acta 22, 365-8(1949) Aug. (in German).

The relative energies of α particles emitted by U^{235}, U^{238}, and U^{234} were determined with the aid of an ionization chamber and two different forms of a pulse-spectrograph, one comprising 19 canals with separate counters, the other with cathode-ray tubes and photographic recording. Both instruments gave concording results. It was found: $(E_{235} - E_{238})/(E_{234} - E_{238}) = 0.365 \pm 0.015$, and $E_{235} = 4.393 \pm 0.01$ Mev; half-life of $U^{234} = (2.33 \pm 0.1).10^5$ years, half-life of $U^{235} = (8. \pm 1.5).10^8$ years. years.

2332 The disintegration of Ce^{141}. Michel Ter-Pogossian, C. Sharp Cook, C. Harold Goddard, and J. Eugene Robinson. Phys. Rev. 76, 909-13(1949) Oct. 1.

The β and γ rays from 28-day Ce^{141} have been studied in a β-ray spectrometer. The maximum β-particle energy is 560 kev and γ rays at 146 kev and 315 kev have been found. With the additional aid of β-γ and γ-γ coincidence studies a disintegration scheme is proposed. In addition the maximum β energy of Pr^{143} has been determined as 920 kev.

2333 Electron pair creation by a spherically symmetrical field. S. Devons and G. R. Lindsey. Nature 164, 539-40(1949) Sept. 24 (Letter to the editor).

The average angular correlation between the directions of the positrons and electrons emitted by the O^{16*} nucleus has been measured using coincidence counters. The pairs are created when the O^{16*} nucleus decays to the ground state following the reaction $F^{19}(p,\alpha)O^{16*}$. On the assumption that both O^{16} states have $J = 0$ and even parity, the angular correlation of positive and negative members of a pair can be calculated from Dirac's electron theory. The theoretical curve thus obtained is in good agreement with the experimental results.

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2334 Gamma-radiation from Br^{82}. Kai Siegbahn, Arne Hedgran, and Martin Deutsch. Phys. Rev. 76, 1263(1949) Oct. 15 (Letter to the editor).

The γ radiation from Br^{82} has been re-examined using higher resolution than the previously published investigation (Roberts et al Phys. Rev. 60, 544(1941)). A double-focusing spectrometer (ρ = 50 cm) with the resolution of the instrument set to ~1% was used. The energies of the seven γ rays as obtained from photo-electron lines and internal conversion spectrum lines are tabulated. Previously it was thought that the disintegration scheme was simpler, consisting of only three γ rays.

2335 An investigation of the secondary electron spectrum of Au^{198}. P. E. Cavanagh, J. F. Turner, D. V. Booker, and H. J. Dunster. Atomic Energy Research Establishment Report AERE N/R-353, July 1949. 27p.

The secondary electron spectrum of Au^{198} has been studied using very large sources, up to 0.3 curies, in a magnetic lens spectrometer. In addition to the well-known γ ray at 0.411 Mev, evidence of 2 much less intense, higher energy, γ rays at 0.67 Mev and 1.09 Mev, has been found, both from the Compton and the photoelectric spectra. The intensities of these two γ rays with respect to the one at 0.411 Mev, have been measured. Two photoelectric peaks at low energy, in about the region expected for Kα and Kβ x-radiation from elements in the neighborhood of gold, have been examined with radiators of different atomic number. The radiation responsible for these peaks has been subjected to critical absorption measurements in the spectrometer. Its behavior is compatible with the Kα and Kβ x-radiation of gold, and no evidence of platinum x-radiation, such as would suggest K-capture, has been found. 20 references.

2336 Investigation of the β spectrum and the γ radiations of As^{76}. Nadine Marty, Jeanne Labeyrigue, and Hélène Langevin. Compt. rend. 228, 1722-4(1949) May 30 (in French).

The β^- and γ spectra of As^{76} (26.75 hr), obtained from As^{75} by the (n,γ) reaction, were studied with the aid of a mass spectrometer with a 1.3% resolution power, the trajectories used being 12 cm in diameter; the instrument was provided with two counters, separated by a 0.5 micron Al foil and working in coincidence. The γ radiation was investigated by placing the source in a brass capsule that retained the electrons, and by determining the energies by way of the Compton effect or the photoelectric effect. Two lines were found: 566 to 568 kev (depending on effect used) and 1250 kev (photoelectric effect). The β^- spectrum showed a maximum at 3.08 Mev; using the known γ radiations, the following maxima of the component spectra were found from the corresponding Fermi lines: 3.15, 2.56, 1.5, and 0.4 Mev, with the relative intensities 54, 21, 19, and 7%, respectively. No conversion lines or positive electrons were observed.

2337 A new gamma-ray resonance in the reaction $C^{12}(p,\gamma)N^{13}$. D. M. Van Patter. Phys. Rev. 76, 1264-5(1949) Oct. 15 (Letter to the editor).

A previously unreported γ-ray resonance has been found for the reaction $C^{12}(p,\gamma)N^{13}$. It was first located by the measurement of the γ rays from a thick graphite target bombarded by protons. The detector consisted of thin-walled β counters in coincidence, which measured the secondary electrons from a thick aluminum converter. The excitation curves gave a resonance at an average proton bombarding energy of 1.697 ± 0.012 Mev with a half-width of 74 ± 9 kev. The ratio of thick-target yields from the 1.70, 0.456-Mev $C^{12}(p,\gamma)$ resonances was measured as 1.3 ± 0.2 from the N^{13} activity, and the thick-target yield of the 1.70-Mev resonance was determined as $(9.4 \pm 1.4) \times 10^{-10}$ quanta/incident proton. Calculations of the corresponding energy levels were made which indicate energy levels in N^{13} at 2.383 ± 0.018 and 3.53 ± 0.027 Mev. A search was made for additional resonances. In the energy range 0.95- to 1.6-Mev proton bombarding energy, no resonance was found with a peak intensity greater than 0.04 of the peak intensity of the 1.70-Mev resonance. From 1.6 to 2.1 Mev, no resonance occurred greater than 0.12 of the maximum intensity of the 1.70-Mev resonance. It is noted that energy levels of N^{13} do not correspond with those of its mirror nucleus C^{13}, as would be expected for equal neutron-neutron and proton-proton forces.

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2338 Radioactivity in holmium 166, thulium 170, and lutecium 177. J. M. Cork, H. B. Keller, and A. E. Stoddard. Phys. Rev. 76, 986-7(1949) Oct. 1 (Letter to the editor).

The conversion electron lines produced following the irradiation of holmium, thulium and lutecium in the Oak Ridge pile, which were recorded photographically, have been tabulated. Observations were also made of the half-lives and, using absorption methods, of the β and γ energies. The low-energy γ ray in each element gave rise to electron lines attributable not only to the K, M, and N levels but also to the sub groups of the "L" level. Failure to recognize this complexity of structure for low-energy γ rays has led to the assumption by the present authors of non-existent γ rays in certain other heavy elements. The following data were obtained: (1) Ho^{166}; β end point at 1.64 Mev. 27.7-hr half-life, and γ rays at 81.0 kev. and 0.92 Mev; (2) Tm^{170}: β end point at 0.9 Mev, half-life probably 120 days, and 84.3-kev γ ray; and (3) Lu^{177}; β end point at 0.46 Mev. 6.8-day half-life, and γ rays at 113.1 and 208.6 kev.

2339 Calculation of the potential from the asymptotic phase. Part II. Carl-Erik Fröberg. Arkiv Mat. Astron. Fysik 36 A, No. 11 (1949) 55p.

The results obtained in a previous paper (Arkiv Mat. Astron. Fysik 34 A, No. 28 (1948)), in which the problem of determining the interaction between two particles from the phase shift for the case of elastic scattering was considered, have been extended. A simplified formula for the first approximation is obtained which can also be generalized. The second approximation is obtained, too, and the method of arriving at higher approximations is also indicated. The methods used are more direct, in most cases originating with the differential equation for the radial part of the wave-function. The necessary convergence conditions are derived and special attention is given to the well-potential, the Gaussian potential, and the Yukawa potential. Some useful formulas, mostly generalizations of Dirichlet's discontinuous factor, are collected in an appendix.

2340 Calculation of self-energy of particles. Meson with spin zero. J. McConnell. Nature 164, 218-19(1949) Aug. 6 (Letter to the editor).

The self-energy problem for the meson with spin zero is considered and the many-time formalism of Kanesawa and Tomonaga (Progress Theoret. Phys. 3, 101(1948)) is applied. The results obtained leads to the mass correction, m^2, being replaced by $m^2\left\{1-\frac{3K+1}{4 \times 137\pi}\right\}$ in which $K = \log \eta$, and η is an invariant which should tend to zero. By invariantly cutting off a variable with the dimensions of a mass squared, it is possible to make η non-vanishing and so re-normalize the mass.

2341 Calculation of self-energy of particles. Particles with spin one. W. Heitler and J. McConnell. Nature 164, 219-20(1949) Aug. 6 (Letter to the editor).

The self-energy of a particle of spin one has been calculated up to terms in e^2. An ambiguity which arises is solved by applying the process of regularization developed by Pauli and Villars (Revs. Modern Phys. 21, 434(1949)). When regularization is applied to electromagnetic self-energies, it appears that these diverge only logarithmically for all particles thus far considered (i.e., spin 0, 1/2, 1) and are, therefore, presumably very small. This is of interest for meson theory since the charge symmetry of nuclear forces requires very nearly equal masses for the charged meson and the neutrino, and this can only be the case if the electromagnetic self-energy of the former is very small.

2342 Classical electrodynamics in terms of direct interparticle action. John Archibald Wheeler and Richard Phillips Feynman. Revs. Modern Phys. 21, 425-33(1949) July.

A re-analysis of the field concept has been made by returning to classical electrodynamics. The motion of a system of charged particles under the influence of electromagnetic forces is considered and an attempt is made to formulate a description of the interactions and motions which is simple, well-

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defined, and in agreement with experience. These requirements are satisfied by the Schwarzchild-Tetrode-Fokker theory of direct interparticle interaction (Göttinger Nachrichten, 128, 132(1903); Z. Physik 10, 317(1922); 58, 386(1929); Physica 9, 33(1929); 12, 145(1932)). In this theory, no direct use is made of a notion of "field" and each particle moves in compliance with the principle of stationary action which contains all of mechanics and electrodynamics in a single variational principle. The consistency of this theory and its relation to field theory are investigated in the following steps: (1) an examination of the paradox of advanced actions; (2) the derivation of the equations of motion from the variation principle; (3) the demonstration that the aforementioned equations of motion satisfy the principle of action and reaction as generalized to the non-instantaneous forces of a relativistic theory of action at a distance; (4) the formulation of the corresponding laws of conservation of energy and momentum; and (5) the establishment of the connection between the aforementioned conservation laws and the field-theoretic description of a stress energy tensor defined throughout space and time. From the results obtained it is concluded that the theory of direct interparticle action, and the equivalent adjunct field theory, provide a physically reasonable and experimentally satisfactory account of the classical mechanical behavior of a system of point charges in electromagnetic interaction with one another, free of the ambiguities associated with the idea of a particle acting upon itself.

2343 Electromagnetic interactions of a vector meson with a scalar excited state. Marshall N. Rosenbluth. Phys. Rev. 76, 951-7(1949) Oct. 1.

A relativistically invariant formalism is presented for a theory of a meson possessing a vector and a scalar state of different mass which are tightly coupled by the electromagnetic field. It is found that the theory reduces formally to the theory of a five-dimensional vector meson, with the constant which couples the states playing the role of a fifth component of the energy-momentum vector. With a large coupling constant there is a high probability for producing excited-state mesons, and hence decay photons, in electromagnetic processes; e.g., by Rutherford scattering on passage of a beam of mesons through heavy material. The production of many photons in nucleon-nucleon scattering, such as has been reported at Berkeley, might possibly be interpreted as resulting from the decay of excited-state mesons which are produced directly. It is also found that the existence of a scalar excited state aggravates the high energy divergences of vector meson cross sections for such electromagnetic processes as the Compton effect, so that the validity of the Christy-Kusaka argument (Phys. Rev. 59, 414(1941)) against the μ meson having spin 1 is not affected by the possible existence of a scalar excited state.

2344 Erratum: bremsstrahlung in high energy nucleon-nucleon collisions. J. Ashkin and R. E. Marshak. Phys. Rev. 76, 989(1949) Oct. 1 (Letter to the editor) (See also NSA 3-1257).

Through an oversight one set of intermediate states was omitted in the matrix element for the γ emission accompanying proton-proton or neutron-neutron collisions (Phys. Rev. 76, 58(1949)). With this correction equations (8) and (9) become incorrect and there is found to be no γ emission in the collision of like particles. It is concluded that there is no electric dipole emission with the approximations made; a classical argument is used in the electric emission case and this is justified by showing that formula (6) can be deduced from a completely classical treatment of the bremsstrahlung.

2345 Examples in which the perturbation method fails. T. Kato. Progress Theoret. Phys. 3, 313-14(1948) July-Sept. (Letter to the editor).

Although the perturbation method in quantum mechanics attempts to solve the eigenvalue problem, etc., of a linear operator $H_x = H_o + xV$ of Hilbert space $\mathfrak{H}$ by means of the development into power series of the small parameter x, and the convergence of the results is usually assumed, it is known that this procedure is not mathematically justifiable. Several cases in which the formal perturbation theory is not applicable are noted. The examples indicate that (1) the formal series of the perturbation theory may be quite meaningless even if no divergence occurs, and (2) the occurrence of divergence, on the other

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hand, does not necessarily mean that any of the following are true: (a) the eigenvalue τ_T in question does not exist, (b) the transition probability is infinite, (c) something like "cutting-off" is inevitable, or (d) the operator H_X is not allowed.

2346 The future nuclear interaction. Alex E. S. Green. Phys. Rev. 76, 870-1(1949) Sept. 15 (Letter to the editor)(See also NSA 3-1021).

The energy of the interaction of nucleons in the future theory, expressible in the form V = OJ, is considered. The operator O, which contains the isotopic, Dirac matrix, and positional coordinates of the nucleons, has been sought among the various developments of one-meson theory, since promising forms of J have been derived recently (Phys. Rev. 75, 1926(1949)). The following three tests are proposed to augment those previously formulated (Wigner, Phys. Rev. 51, 106(1937)): (1) the interaction must be well-behaved in the limit of zero-meson, reducing to a reasonable Newtonian or Coulombian interaction; (2) the dipole terms must have as co-factors a natural length which is characteristic of the nucleons, rather than the field, in correspondence with the classical case; and (3) the infinite self-energies and inadmissible interaction singularities among static and relativistic terms must vanish when Yukawa's potential is replaced by the author's generalized meson potential. These tests are applied to the 4 interactions derived by Kemmer (Proc. Roy. Soc. A166, 145(1938)). It is suggested that these interactions can be used after making suitable modifications, by regarding them as 8 distinct interactions, 4 of which, the pole cases, have a more elementary nature.

2347 Gauge invariance and rest mass. K. J. Le Couteur. Nature 164, 106(1949) July 16 (Letter to the editor).

In view of present interest in the self-energy of the photon, the existence of several gauge-invariant wave equations which can describe quanta of non-zero rest mass is noted. Some equations of this type are considered in relation to the problem of the self-energy of the photon. It is noted that gauge invariance does not insure that calculations of the finite part of the energy of a photon, if the approximation is carried far enough to obtain to a high degree of accuracy, will necessarily lead to the desired result. It is also noted that the finite self-energy calculated by Wentzel (Phys. Rev. 74, 1070 (1948)), being equivalent to an addition of $1/2(\gamma A_\mu{}^2(x))$ to the photon Hamiltonian, cannot be adsorbed into the theory outline, in which the addition to the Hamiltonian must involve derivatives of the field strengths.

2348 Heisenberg's S matrix for a system of many particles. R. J. Eden. Proc. Roy. Soc. (London) 198A, 540-59(1949) Sept. 7 (See also NSA 1-1675).

When creation and annihilation of particles is forbidden, the general features of a many-particle collision are illustrated by a scattering system containing 2 particles and a fixed scattering center. The term in the wave function, which Møller terms the "outgoing" part, is shown to contain a term representing a totally outgoing wave, and also terms describing the interference effects between the incident wave of one particle and the outgoing wave of the other. Corresponding to the latter terms, there exist singular eigenstates of the S matrix which are simultaneous eigenstates of the separate kinetic energies of the particles. The remaining eigenstates are called "non-singular," and for these only the sum of the kinetic energies can be given a definite value. Analytic continuation of the non-singular eigenstates in the complex plane of total kinetic energy shows that the corresponding eigenvalues of S can be used to determine the energy levels of states with both particles bound to the center of force. The eigenvalues for the singular eigenstates will lead to the bound energy of a single particle in the scattering field of the other. The formalism is extended to include singular eigenstates which describe the scattering of one particle on a compound center made up of the other particle bound to the scatterer.

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2349 Interaction between elementary particles. Part I. Alfred Landé. Phys. Rev. 76, 1176-9(1949) Oct. 15.

An elementary particle is considered as a mathematical point which under an invariant law of communication involving a universal length "a" establishes a primary potential in space-time. Due to the peculiar communication law, $r^2 - c^2t^2 + a^2 = 0$ or $S^2 = 0$, in contrast to the light-signal law $R^2 = 0$, the primary potential is without singularity at $r = 0$. It becomes the background of a regular electrodynamic or mesonic field and automatically yields a finite radius "a" to the charge distribution, with a density falling off as $(a/r)^5$ at larger distances. The potentials of different particles are additive so that all quantities obey the superposition law. The total force on the Nth particle is produced under the same invariant communication law $S = 0$ by integration of the force density k_N over the volume elements of the instantaneous rest system. (K_N is the resultant of mutual and self-forces, $K_N = S_M K_{MN}$). Only retarded field interaction is admitted between different particles. The original production of the self-charge by the center and its force reaction on the center is derived from a heuristic scheme involving half-retarded, half-advanced potentials, as a substitute for the instantaneous reaction between the "parts" of a charge. In the dynamics of the particle a variable "acceleration mass" of field origin is added to the mechanical mass. An experimental determination of mass differences under various very high accelerations could reveal the unknown ratio between the field mass and the mechanical mass of a charged particle.

2350 Motion in a constant magnetic field. M. H. Johnson and B. A. Lippmann. Phys. Rev. 76, 828-32(1949) Sept. 15.

The motion of a charged particle in a constant magnetic field is treated in both relativistic and nonrelativistic quantum theory. Operators representing the center of the orbit, which obey the commutation law for conjugate variables, are introduced and their connections with energy, angular momentum, and magnetic moment studied. Energy eigenfunctions in an operator form are obtained by factorization. Previously derived eigenfunctions in coordinate space are obtained and are shown to be eigenfunctions for the operators for the center of the orbit as well as for the energy. Corresponding relativistic eigenfunctions are derived by a simple device which enables the construction of solutions of the Schrödinger equation.

2351 A new formulation of the variational principle for scattering problems. Su-Shu Huang. Phys. Rev. 76, 866-7(1949) Sept. 15 (Letter to the editor).

A formulation of the variational principle for scattering problems is given which is believed to combine the merits of the methods of Tamm (Zhur. Eksptl. i Teoret. Fiz. 18, No. 4 (1948)) and Hulthén (Kgl. Fysiograf. Sällskap. Lund, Förh. 14, No. 21 (1944)) without their disadvantages. By means of a particular substitution of Euler equations of a known variational problem are obtained; this method is applied (1) to the head-on collision of two particles, (2) to collisions of higher angular momenta, and (3) to the S-scattering of electrons by a neutral hydrogen atom. It is noted that the form suggested has the advantage of simplicity for practical applications.

2352 On the connection between phase shifts and scattering potential. V. Bargmann. Revs. Modern Phys. 21, 488-93(1949) July.

Phase equivalent potentials, i.e., of potentials which give equal phase shifts for S-waves, have been formulated and discussed. In particular, it is shown that the phase shifts do not determine the energy of bound states, and that there exist continuous families of phase equivalent potentials.

2353 On the field equations in quantized field theories. Gregor Wentzel. Z. Naturforsch. 3a, 430-4(1948) (in German) (See also NSA 3-1776).

The general equations in the quantum theory of fields are written in relativistically invariant form using the Tomonaga equation. The renormalization of the mass of a scalar particle by means of a unitary transformation is discussed.

PHYSICS (continued)

2354 On a form of nonrelativistic eigenfunctions for a particle with positive energy in a Coulomb field. S. Franchetti. Nuovo cimento 6, 274-82(1949) July (in Italian).

The Wentzel-Kramers-Brillouin method of finding approximate solutions of unidimensional wave equations has been applied to the radial part of the continuum eigenfunctions for a nonrelativistic particle in a Coulomb field of force. The approximate formulas obtained (in finite form) are of asymptotic character and they converge very rapidly to the exact values when the radial distance increases. They are particularly useful to determine approximate values for the zeros of the eigenfunctions, which in turn can help calculate approximatively integrals involving the functions in question.

2355 On meson fields and conformal transformations. J. A. Schouten. Revs. Modern Phys. 21, 421-4(1949) July.

Some of the interesting features of the mathematical side of the problem of conformal relativity are discussed in an attempt to stimulate physical investigations along these lines, using general homogeneous curvilinear coordinates and not only a subgroup of the conformal group but the whole group itself. The work of various investigators who have worked on conformal relativity is reviewed, and the relationship between this work and meson theory is considered.

2356 On a new conception of the interaction between charges and electromagnetic field. Louis de Broglie. Phys. Rev. 76, 862-3(1949) Sept. 15 (Letter to the editor).

The interaction between charges and the electromagnetic field has been investigated by means of a new approach which utilizes the suggestions of Feynman (Phys. Rev. 74, 939(1948)). Using the multitemporal theory and starting from a particular form of Wentzel potentials (in non-rationalized units) an expression for the charge density is obtained which has the form of a Yukawa potential. It is concluded that the interaction between electrical charges takes places with the simultaneous intervention of a photon field and a meson field, each charge reacting in an opposite manner with these two fields; the meson charge η is equal and opposite to the electric charge ϵ. If the meson field is abstracted it is necessary to replace the point charge by the continuous distribution. The results are also obtained from the wave-mechanical equations of the photon and the same expression for the charge density is obtained when the proper mass of the photon is zero. Further results obtained indicate that the coincidence potential plays a very important part, and this seems to supply a serious reason for believing that the proper mass of the photon is not quite rigorously zero, in accordance with the generalization of the wave mechanics of the photon to the general theory of particles of spin 1.

2357 On the rigorously defined point charges. A remark on the classical electron theory. Erich Kretschmann. Ann. Physik 4, 331-4(1939) Mar. (in German).

It is shown that the assumption of a rigorously defined elementary point charge can be brought into agreement with the laws of conservation of linear and angular momenta. The following are among the consequents drawn from this modification in the electron theory: The energy density of the field can be negative, as well as positive. In any radiation of energy at least two elementary charges are involved; both charges must be accelerated.

2358 On simultaneous interaction of several fields and the self-energy problem. Jerzy Rayski. Acta Phys. Polon. 9, 129-40(1948).

The problem of simultaneous interaction of several fields is investigated within the framework of the Heisenberg-Pauli formalism. For a suitable mixture of fields of the well known types, the divergent parts of the self-energy terms may be eliminated. The problem of vacuum charge fluctuations is studied, with the result that, for a suitable mixture of charged spinor and scalar fields, the photon self-energy vanishes. The calculations go to the second order of approximation in e^2 only.

PHYSICS (continued)

2359 On a projective relativity theory with variable gravitational invariants. II. Variation principles and field equations for gravitation and matter. Guenter Ludwig. Z. Physik 125, 545-62(1949) (in German) (See also NSA 3-1619).

The first part of the present work was published in Z. Physik 124, 450(1948). In the present paper the fundamental field equations are given for the gravitational and the electromagnetic fields, as well as for the κ-field, κ denoting the gravitational invariant. Formal expressions are derived for the energy-momentum tensor and the quadruple current of matter, and the corresponding conservation laws studied. An appropriate framework for a cosmological model is discussed.

2360 On the relativistic invariance of the canonical field equations and the location of energy, momentum, and angular momentum in a field. J. M. Jauch. Anais acad. brasil. cienc. 20, 353-61(1948).

The quantum theory of fields is formulated in a general form. The theory of canonical transformations and their relation to Lorentz transformations is treated and the method of introducing momentum-, energy-, and angular momentum-densities is described.

2361 On the solution of relativistic wave equations. F. I. Fedorov. Doklady Akad. Nauk. S.S.S.R. 65, 813-14(1949) Apr. 21 (in Russian).

A general solution is given of the system of 2 relativistic wave equations $H\psi_0 = 0$, $(H + U)\psi = 0$. The method is applied to the problem of the scattering of light by a free particle.

2362 On the theory of the multipole radiation. M. Fierz. Helv. Phys. Acta 22, 489-500 (1949) Aug. (in German).

A simple calculation is made of the intensity and the characteristics of the lowest multipole wave emitted by an electromagnetic source. General formulas are derived for the correlations of γ rays, with the aid of the rotation group theory.

2363 On the theory of quantized space-time. V. L. Averbakh and B. V. Medvedev. Doklady Akad. Nauk. S.S.S.R. 64, 41-4(1949) Jan. 1 (in Russian).

The Snyder's theory of quantized space (Phys. Rev. 71, 38(1947)) is here considered as a study of the movement group of a hypersphere in a five-space, the problem being solved uniquely if the coordinates satisfy certain conditions. In Snyder's scheme the moments are not translational operators, as is the case in the current theory. The concept of derivatives with respect to coordinates has no sense in a quantized space; the equations have to be considered as pertaining to a space different from the coordinate space, which can be called "the wave equation space." The point charge of the usual theory is here spread out in four dimensions and the concept of charge density has to be given a special interpretation.

2364 On the uniqueness of the potential in a Schrödinger equation for a given asymptotic phase. N. Levinson. Kgl. Danske Videnskab Selskab. Mat. Fys. Medd. 25, No. 9, 1949. 29p.

With suitable hypotheses it is shown that $\phi(\mu)$ determines $P(x)$ and $A(\mu)$ uniquely and that the converse is also true in the case of $A(\mu)$ in which

$$\lim_{x \to \infty} \left[y(x,\mu) - \frac{A(\mu)}{\mu} \sin(\mu x - \phi(\mu)) \right] = 0,$$

where $A(\mu)$ and $\phi(\mu)$ are continuous functions of μ, $0 < \mu < \infty$, and the function $\phi(\mu)$ is the asymptotic phase. The above equation is satisfied by the solution $y(x,\lambda)$ of the differential equation: $y'' + \lambda^2 - P(x)\, y = 0$, with initial values $y(0,\lambda) = 0$ and $y'(0,\lambda) = 1$, in the case where $P(x)$ is small enough for large values of x and $\lambda = \mu \neq 0$, where μ is real. It is noted that examples of cases where the phase does not determine the potential (owing to the presence of discrete characteristic values, i.e., bound states) have been given by Bargmann (Phys. Rev. 75, 301(1949)).

PHYSICS (continued)

2365 Processes between light particles according to Dirac's theory. B. Kockel. Ann. Physik 4, 279-302(1949) Mar. (in German).

Processes between electrons and positrons are studied, in which no heavy particles are involved and the state changes of the electrons are accompanied by an emission or as absorption of photons. The probabilities are calculated of the simplest of such processes, viz. of the Compton effect and of the generation and annihilation of an electron-positron pair. The probability is given for the special case of an annihilation of a pair with a formation of three light quanta; it is found that, for high pair energies, this "three-quantum" annihilation occurs with the same, or greater, probability than the "two-quantum" annihilation; this shows the inadequacy, for high energies, of a classification of annihilations according to the number of photons emitted. Further it is shown that no process is possible in which more than one electron undergoes state changes, whatever the number of light quanta involved; for example, the simultaneous formation of two pairs out of photons is impossible. The significance of this result is discussed, as well as its dependence both on the electron eigenfunctions used in the calculation, and on the disturbance-theoretical element introduced into it.

2366 Radioactive collisions of two electrons. Jan Rzewuski. Acta Phys. Polon. 9, 121-7(1948).

The differential cross section is calculated for a radioactive collision of two particles, under the assumptions that both particles obey the Dirac equation and that the interactions between them are static. In the limiting case, when the mass of one of the particles approaches infinity, the formula of Bethe and Heitler (Proc. Roy. Soc. (London) 146, 83(1934)) is valid. Another formula is here given for the case of high energies, where the change in momentum of the heavy particle cannot be neglected. The effective cross section for the radioactive collision of two electrons, given by the latter formula, vanishes for small velocities, and, in the case of high velocities, reaches the order of magnitude of Bethe-Heitler's cross section for the bremsstrahlung. The same formulas are valid for the reverse process of pair production in the field of an electron.

2367 Space-time approach to quantum electrodynamics. R. P. Feynman. Phys. Rev. 76, 769-89(1949) Sept. 15.

It is shown that a considerable simplification can be attained in writing down matrix elements for complex processes in electrodynamics. Also, a physical point of view is available which permits them to be written down directly for any specific problem. However, as a restatement of conventional electrodynamics, the matrix elements diverge for complex processes. Electrodynamics is modified by altering the interaction of electrons at short distances. All matrix elements are now finite, with the exception of those relating to problems of vacuum polarization. The latter are evaluated in a manner suggested by Pauli and Bethe, which gives finite results for these matrices also. The only effects sensitive to the modification are changes in mass and charge of the electrons. Such changes could not be directly observed. Phenomena directly observable, are insensitive to the details of the modification used (except at extreme energies). For such phenomena, a limit can be taken as the range of the modification goes to zero. The results then agree with those of Schwinger. A complete, unambiguous, and presumably consistent, method is, therefore, available for the calculation of all processes involving electrons and photons. The simplification in writing the expressions results from an emphasis on the overall space-time view resulting from a study of the solution of the equations of electrodynamics. The relation of this to the more conventional Hamiltonian point of view is discussed. It would be very difficult to make the modification which is proposed if one insisted on having the equations in Hamiltonian form. The methods apply as well to charges obeying the Klein-Gordon equation, and to the various meson theories of nuclear forces and illustrative examples are given. Although a modification like that used in electrodynamics can make all matrices finite for all of the meson theories, for some of the theories it is no longer true that all directly observable phenomena are insensitive to the details of the modification used. The actual evaluation of integrals appearing in the matrix elements may be facilitated, in the simpler cases, by methods described in the appendix.

PHYSICS (continued)

2368 Spin and wave function of an elementary particle. P. Román. Nature 164, 406-7(1949) Sept. 3 (Letter to the editor).

It is shown that there does not exist a mutually definite correlation between the spin and the transformation properties of the wave function of an elementary particle, as has been generally assumed. In particular it is demonstrated that the wave equation $(\alpha_\nu \partial_\nu + \mu)\psi = 0$, where $\mu = mc/\hbar$, the Greek suffixes run from 1 to 4, and the operators α_ν fulfill the following anticommutation rules:

$$\alpha_i\alpha_k + \alpha_k\alpha_i = \delta_{ik} \qquad (i,k \neq 4)$$
$$\alpha_i\alpha_4 + \alpha_4\alpha_i = \alpha_i$$
$$\alpha_4^2 = \alpha_4$$

results in a spin of $\pm 1/2\ \hbar$ and a magnetic moment of $c\hbar/2mc$ for the electron, just as in the case of the Dirac equation; however, in the former the components of the wave equation do not transform as spinors do and the wave-equation is not Lorentz-invariant.

2369 The theory of the electron applied to the study of the mass spectra of elementary particles. Fritz Bopp. Z. Physik 125, 615-28(1949) (in German).

On the basis of the Mie-Born theory of the electron, the relationship is investigated between the structure of the elementary particles and the observed mass-spectra. By taking into account the processes of emission and re-absorption, the wave equation of the field mechanics is derived and discussed. The annihilation effects are left outside the scope of the present discussion. This work is a continuation of another paper published in Z. Naturforsch. 1, 196(1946).

2370 Three-body scattering with central and tensor forces. Roy Thomas. Phys. Rev. 76, 1002-3(1949) Oct. 1 (Letter to the editor).

The scattering of neutrons and deuterons (or protons and deuterons) has been calculated using a combination of central and tensor type interactions. The Born approximation is used in calculating the cross section for scattering, although its use is questionable in view of the fact that the kinetic energy is of the same order as the interaction energy. By means of spin theory with annihilation operators, the evaluation of the spin sums is completed, eliminating the necessity for an explicit formulation of the spin wave function. It is noted that the coulomb repulsion is neglected in the calculations. The cross sections are given for the five exchange operators, G_{ij}, in the following formulations: (1) ordinary, (2) Majorana, (3) Heisenberg, (4) charge symmetric, and (5) charge and spin symmetric. The exchange operator, G_{ij}, appears in the expression used for the interaction between any two elementary particles. It is noted that exchange operators (2) and (3) give the same tensor contribution to the scattering, and also the tensor contributions of (4) and (5) are equivalent. For relative energies less than 10 Mev the tensor contribution may be disregarded compared to the magnitude of the cross section from the central interactions only. For relative energies of the order of 20 Mev, the tensor terms make an appreciable contribution to the cross section. This contribution changes the angular behavior of the cross sections in a marked manner for the symmetric exchange of cases (4) and (5).

2371 The uncertainty principle. H. V. Stopes-Roe. Nature 164, 245-6(1949) Aug. 6 (Letter to the editor).

Cowley's discussion of Heisenberg's uncertainty principle (Nature 163, 492(1949)) is discussed. The confusion existing in the literature between two distinct ideas, both referred to as "the uncertainty principle" is noted. One of these can be derived from the old quantum theory of Planck, Einstein, and Bohr and the other from the new quantum theory.

2372 The uncertainty principle. W. L. Cowley. Nature 164, 246(1949) Aug. 6 (Letter to the editor) (See also NSA 2-2017).

The author defends his previous discussion of the uncertainty principle (Nature 163, 492(1949)) which has been criticized by Stopes-Roe (Nature 164, 245(1949)). The "duality of quantum theory logic" is discussed, particularly with reference to the uncertainty principle.